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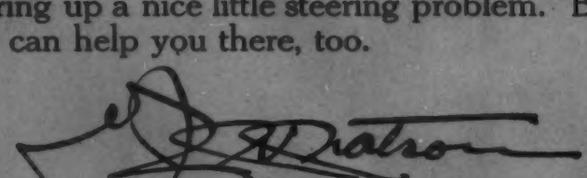
THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

JUNE 1924

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

YOU may well cease to worry about your rear springs—they are all right. Your front springs though are terrible. As a matter of fact, I don't see why we all flatter them by calling them springs. There is just about as much spring in them as there is in the month of March in Albany. How are you going to climb over a 6-inch bump without feeling it when your front springs are permitted only 2½ inches of travel before they hit bottom?

You say that stiff front springs are used to prevent violent "bobbing" and loss of car-control. That's all perfectly true, but if you are ever going to build easy riding into your motor cars you will have to supple-up these front springs and find some other way to cut down the "bobbing". There is no trick or mystery about building easy riding into a motor car. But you must start off right. If you are going to travel over bumps 5- or 6-inches high without feeling them it is quite obvious that you must provide a cushion having a 5- or 6-inch swallowing capacity. After you have provided these cushions (you already have them on the rear of your car) then put it up to us to nicely eliminate the "bobbing". And don't forget that a 5- or 6-inch front cushion is going to bring up a nice little steering problem. But maybe we can help you there, too.



President

JOHN WARREN WATSON COMPANY
Twenty-fourth and Locust Streets
PHILADELPHIA

WATSON STABILATORS

Change the Whole Nature of Your Car

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. XIV June, 1924 No. 6

Chronicle and Comment

Summer Meeting This Month

AT the moment this issue of THE JOURNAL goes to press, 457 reservations have been made for the Summer Meeting at Spring Lake, N. J., June 24 to 27. This large total, with the opening day more than 2 weeks away, assures a successful meeting from the standpoint of attendance. While three hotels assure plenty of room for everybody, members should not delay the filing of their reservations. Turn to p. 566 and note the complete announcement of the valuable technical program, the special railroad trains, the reduced-fare plan and all the other features of this important gathering of automotive executives and technical men.

A New Section and a New Name

HENCEFORTH the city of Milwaukee will boast a Section of the Society. The conscientious efforts of a group of members residing in the Wisconsin metropolis have resulted in the staging of a successful season of meetings and the Council voted at its May meeting to give this probationary group the full standing of a regular Section. With this recognition the Milwaukee Section is entitled to representation on the Nominating Committee of the parent Society and will receive financial support from the national body along with the other Sections. The addition of the Milwaukee Section brings the total of organized local outposts of the Society up to 12.

Coincident with the establishment of a Section in Milwaukee, the name of the Mid-West Section becomes the Chicago Section. The change is made at the suggestion of the officers of the Chicago Section, who believe that the new name more nearly identifies the Section with the immediate circle of its activity.

Nominating Society Officers for 1925

THE nomination of a group of members to serve as officers of the Society in 1925 will probably be completed and announced at the Summer Meeting by the Nominating Committee of the Society. This committee consists of Members elected by the Sections, each naming one man and an alternate, and three Members of the Society elected at the Business Session of the Summer Meeting. There being 12 Sections, the Nominating Committee will have 15 members at Spring Lake. The following have been named for service on the 1924 Committee by the Sections:

Section	*Member*	*Alternate*
Buffalo	J. W. White	None
Chicago	R. E. Wilson	H. O. K. Meister
Cleveland	Orrel A. Parker	William E. England
Dayton	E. Dickey	H. C. Mougey
Detroit	T. J. Litle, Jr.	J. E. Schipper
Indiana	F. F. Chandler	O. C. Berry
Metropolitan	A. C. Bergmann	A. M. Wolf
Milwaukee	(Not selected as yet)	
Minneapolis	A. F. Moyer	None
New England	R. E. Northway	I. D. Shaw
Pennsylvania	F. M. Germane	G. W. Gilmer, Jr.
Washington	A. W. S. Herrington	S. W. Sparrow

The three members-at-large will be elected at Spring Lake on Tuesday evening, June 24; no two of them can reside in the same Section district.

Of Interest to Section Members

SECTIONS matters and problems of the Sections were discussed in a most thorough manner at a meeting of the Sections Committee of the Society held in New York City last month. Fortunately, the meeting was a most representative one, for 8 of the then existing 11 Sections were represented by members of the Committee. In addition, written opinions of representatives of the three remaining Sections on the matters discussed were available for reference at the meeting. Appropriations from the parent Society to enable each of the Sections to complete its season's program were recommended and these have since been approved by the Council. In each instance, these appropriations will cover the payment of Section running expenses to Oct. 1 and leave a substantial cash balance with which to start activities in the fall. With the payment of these appropriations, the parent Society will have forwarded a total of $9,060 to the 11 Sections for the current fiscal year.

Plans were formulated for an effective Sections Meeting at Spring Lake. All officers and chairmen of committees of the Sections will be summoned to this gathering for the purpose of interchanging valuable experience gained in operating Sections successfully. Suitable programs and papers for fall meetings will be decided upon. Means of further increasing the attractiveness of Section meetings will be considered. Effective publicity practices

will be discussed. This meeting is to be held Thursday, June 26, starting at 11 a. m.

Standards Committee Division Reports

EIGHT Divisions of the Standards Committee will present 27 recommendations for approval at the Standards Committee Meeting on Thursday morning, June 26, at the Summer Meeting of the committee in Spring Lake. These are printed in full on pp. 625 to 640 inclusive in this issue. Although the reports, as passed by the Standards Committee, must be approved by the Council and adopted by the voting members of the Society by letter ballot before going into effect, the Standards Committee Meeting presents virtually the last opportunity for Society members or non-members, who are of the opinion that the recommendations do not meet the requirements of the industry, to submit evidence, in person or in writing, supporting their opinions.

In reading the reports in this issue, it should be borne in mind that the recommendations are tentative and may be subjected to extensive revision or even referred back for further study to the Divisions submitting them.

Special attention is called to the introduction by Charles M. Manly, vice-chairman of the Standards Committee. This reviews the function and scope of the several organizations now taking an active part in automotive standardization.

Fuel Research Continues

REPRESENTATIVES of the automobile and the petroleum industries, recently assembled in the City of Washington, were unanimous in their approval of the results thus far accomplished in the cooperative fuel-investigation. Very satisfactory progress has been made toward determining the factors of importance in the establishment of a correct balance between available automotive fuels and present-day engines. The research, moreover, has opened the way to further practical steps in bringing about the best utilization of the crude, the development of a more useful automotive product and the rendering of greatest service to the public.

It was decided that, in continuation of the investigation along the lines laid down in the original program, special emphasis should be directed to the problems of crankcase-oil contamination, engine starting and fuel vaporization. Many interesting developments have come from the experiments recently conducted at the Bureau of Standards, and it is believed that the members of the Society will be greatly interested in the account of these findings that is to be presented at the Summer Meeting.

Constructive Criticism

IT is always good business to get the owner's views regarding the design of any automotive vehicle. This is particularly true in the case of the motor-truck or motorbus operator. The paper by J. F. Winchester which was published in the May issue of THE JOURNAL presented many interesting and pertinent comments on truck design. These are deserving of careful study by enterprising truck engineers since they represent the opinions and experience of a member of the Society who has specialized on the efficient operation of a truck fleet of considerable size. On p. 591 of this issue will be found similarly valuable criticisms of motorbus design which were brought out in the discussion at the May meeting of the Pennsylvania Section.

From this discussion it is evident that several points need the immediate attention of bus designers. Complaints regarding failures in the electric lighting systems are general. Brakes are often inadequate, requiring too frequent adjustment and relining because they are overworked. Means for proper ventilation and heating are not always provided. Of course, buses are in service to which these criticisms do not apply, but it is well to emphasize them here in order that the performance of this latest form of automotive transportation may be raised to the highest level by those responsible for the design of the vehicles.

Sections Elect New Officers

ALL Sections of the Society have announced the election of officers for the year 1924-25. These members will take the reins in earnest, starting with the fall meetings, although they will supervise late spring activities in some cases. The complete list follows:

BUFFALO SECTION	
J. W. White	*Chairman*
E. T. Mathewson	*Vice-Chairman*
L. H. Pomeroy	*Secretary*
H. Youngren	*Treasurer*
CHICAGO SECTION	
Frank C. Mock	*Chairman*
R. E. Wilson	*Vice-Chairman*
Prescott C. Ritchie	*Secretary*
W. J. Buettner	*Treasurer*
CLEVELAND SECTION	
Clyde Pelton	*Chairman*
John Younger	*Vice-Chairman*
L. L. Williams	*Secretary*
H. E. Figgie	*Treasurer*
DAYTON SECTION	
H. W. Asire	*Chairman*
V. G. Apple	*Vice-Chairman*
F. H. Walkley	*Secretary*
F. W. Heckert	*Treasurer*
DETROIT SECTION	
George L. McCain	*Chairman*
W. R. Strickland	*Vice-Chairman*
Fred A. Cornell	*Secretary*
W. C. Keys	*Treasurer*
INDIANA SECTION	
F. F. Chandler	*Chairman*
O. C. Berry	*Vice-Chairman*
George T. Briggs	*Secretary*
D. C. Teetor	*Treasurer*
METROPOLITAN SECTION	
A. F. Masury	*Chairman*
C. T. Myers	*Vice-Chairman*
F. H. Dutcher	*Secretary*
C. B. Veal	*Treasurer*
MILWAUKEE SECTION	
G. W. Smith	*Chairman*
Louis F. Reinhard	*Treasurer*
Walter S. Nathan	*Secretary*
MINNEAPOLIS SECTION	
J. L. Mowry	*Chairman*
C. W. Jacobs	*Vice-Chairman*
Phil N. Overman	*Secretary*
J. S. Clapper	*Treasurer*
NEW ENGLAND SECTION	
V. A. Nielsen	*Chairman*
H. Borreson	*Vice-Chairman*
G. S. Whitham	*Secretary*
L. H. Young	*Treasurer*

PENNSYLVANIA SECTION

B. B. Bachman	*Chairman*
A. E. Hutt	*Vice-Chairman*
Charles O. Guernsey	*Secretary*
George C. Lees	*Treasurer*

WASHINGTON SECTION

A. W. Herrington	*Chairman*
C. H. Warrington	*Vice-Chairman*
Conrad H. Young	*Secretary and Treasurer*

A Prize for Aeronautical Achievement

TO commemorate the pioneer achievement in aeronautics of the Wright brothers, the Dayton Section of the Society proposes to give a medal annually as a prize for the most meritorious contribution to the science of aeronautics reported to them during the year. The contribution to, or the discovery in, the science and art of aeronautics may include advances in aerodynamics, development in the construction of airplanes, their powerplants and accessories which will increase their efficiency or reliability in performance or flight, such as fuel systems, control mechanisms, instruments for aerial navigation, and the like. Improvements of a nature having mainly a military application, such as ordnance or aerial photography, are not included in the list of subjects for which this prize may be awarded. It is the intention to award the prize for contributions designed to stimulate increased non-military use of heavier-than-air craft.

The prize may be competed for by any individual citizen of any country, or group of not more than two individual citizens, without restrictions excepting only that officers of the parent Society, officers of the Dayton Section, members of the Contest Committee and members of the Award Committee are ineligible.

The award will be made for the intrinsic merit of the achievement itself, rather than for the merit of the paper describing it. Flight tests are considered highly desirable and it will be advantageous to the competitor to be able to include in the paper a complete report in regard to flight tests carried out under proper conditions in the presence of unbiased observers. Flight tests, however, will not be absolutely insisted upon, as it is recognized that a proposed improvement might be such that tests by an individual would be financially impossible and yet the improvement would be clearly evident to a competent Award Committee. The paper should be plainly labeled with the name and address of the author. It should be forwarded to the Wright Memorial Committee, Dayton Section, Society of Automotive Engineers, Inc., c/o The Engineers' Club of Dayton, Dayton, Ohio.

The Award Committee will be appointed annually by the Contest Committee of the Section, and for 1925 consists of Prof. E. P. Warner, Massachusetts Institute of Technology, and H. M. Crane, president of the Society. In addition, an airplane designer and a test pilot will be designated. These will preferably be secured from the Air Services of the Army and Navy. On account of uncertainty of assignments in the Air Services, it is not possible to give the names at the present time.

The paper describing the achievement for which the medal is awarded shall be presented originally before the Dayton Section of the Society, either by the prize winner or, if this proves impracticable for any reason, by some member of the local section appointed by its officers. The award for 1924 shall be on the basis of papers received up to Dec. 31, 1924, and shall be announced thereafter as soon as the necessary work in checking up the various papers received and the data contained therein can be completed. The Dayton Section reserves the right to withhold any award if, in the opinion of the Award Committee, no paper of a proper standard has been submitted. The Dayton Section reserves the privilege in future years of restricting the competition to a narrower field of endeavor than is announced for 1924. However, any such restrictions shall be announced by Jan. 1 of the year during which they are operative.

National Service Gathering Successful

THE success of the Automotive Maintenance Equipment Show and Service Convention that was held under the auspices of the National Automobile Chamber of Commerce at the General Motors Building, Detroit, May 19-23, has undoubtedly demonstrated the desirability of establishing it on a permanent annual basis. Interest taken in the meetings and the various exhibits of modern equipment for the maintenance of automotive apparatus by those attending the National Automotive Service Convention and the World Motor Transport Congress held in Detroit during the same week, was perhaps greater than had been anticipated. Among the 105 exhibits in general, were many of modern machinery that has been developed for servicing, including many interesting ones for repairing cylinders, straightening crankshafts, relining and refinishing main bearings and other major servicing operations. Many forms of hand tools and garage equipment were shown.

The exhibit of the Society at the Show was educational, most of it showing the application in commercial practice of S. A. E. Standards and Recommended Practices, particularly those of direct importance in the servicing of automobiles and their equipment. Many opportunities were offered the Society's representatives to explain the standardization work to visitors and to discuss effective means of securing better understanding by dealers and service organizations of the value of its work. The materials exhibited by the Society and the possibility of disseminating information regarding its work resulted from the cooperation of members and their companies who furnished most of the material on display and of the National Automobile Chamber of Commerce which contributed the large and well located space for the Society's booth. A. W. Reader, of the Chevrolet Motor Co., B. M. Smarr, A. R. Nottingham and W. J. Outcalt, of the standards department of the General Motors Corporation, and C. L. Holm, of the engineering department of the National Lamp Works in Cleveland, generously contributed their time at the Society's booth and did much to make its display instructive and interesting. Acknowledgment is made of the prompt and generous response of the following men and their companies to the request of the Society for materials to be placed on exhibition: Robert Jardine, Rich Tool Co.; P. R. Beardsley, Piston Ring Co.; Louis Schwitzer, Automotive Parts Co.; George A. Barnard, Graton & Knight Mfg. Co.; H. E. Morse, Goodyear Tire & Rubber Co.; R. N. Falge, National Lamp Works; E. S. Atkinson, Sherman Mfg. Co.; W. H. Allen, B. F. Goodrich Co.; A. M. Dudley, Westinghouse Electric & Mfg. Co.; B. N. MacGregor, Packard Electric Co.; H. M. Otis, Tubular Woven Fabric Co.; Louis Barber, National Screw & Mfg. Co.; H. T. Owens, National Gage & Equipment Co.; Harold Copleston, Johns-Manville, Inc.; Herbert Jandus, C. G. Spring & Bumper Co.; O. B. Harmon, Midland Steel Products Co.; W. H. Bassett, American Brass Co.; Neil MacCoull, Texas Co.; and C. F. Ogren, Thermoid Rubber Co.

MEETINGS OF THE SOCIETY

SUMMER MEETING JUNE 24-27

Technical and Recreational Features Are Attracting Large Crowd to Spring Lake

In a very short time, June 24-27 to be exact, automotive engineering interest will center about the seashore hamlet of Spring Lake, N. J. Here will assemble the technicians of the motor car and allied industries for the purpose of trading experience on some of their more urgent common problems. In the course of the 4-day period there will be six professional meetings dealing with riding-quality, the contamination and dilution of crankcase-oil, air-cleaners, standards and some of the newer steps in transmission design. Every session will provide useful engineering information, the sum total of which will far outweigh in value the expense of attending the Summer Meeting. Then, besides, there is the social advantage of meeting with the foremost technical men in the industry. Oftentimes the casual conferences on the porch, along the boardwalk or while tramping the links lead to interchange of thought and experience of inestimable value.

Reservations are reaching the New York office in gratifying numbers. It is high time for the tardy ones to send in their applications for rooms.

Excellent Technical Program Provided

Technical activities will start soon after the arrival of the members at Spring Lake. The first session will be held on Tuesday afternoon and will be devoted to the discussion of Riding Quality. J. A. C. Warner, assistant manager of the Society's Research Department, has been making a study of this phase of automobile engineering for many weeks, traveling about the industry interviewing many engineers who have worked on the improvement of riding quality. He has investigated methods of determining riding quality, different types of shock-absorbers and the effects of balloon tires. Mr. Warner will present an analysis of the riding quality problem that will set engineers to thinking along practical lines. Prof. E. H. Lockwood and A. L. Kimball of Yale University have been experimenting with an instrument which records the riding quality of different cars. They have made comparative records of cars using high-pressure and low-pressure tires. Results of these tests and a description of the instrument will be presented at the meeting. Similar experiments have been carried on by F. H. Norton at Massachusetts Institute of Technology with an instrument of a different type[1] and the results will be reported by him. Samuel P. Hess will read a paper on spring design as related to riding quality.

Crankcase-Oil Contamination

Sessions on Wednesday morning and evening will cover the subject of crankcase-oil dilution and contamination. Effects of dilution will be touched upon in nearly all of the papers. A. Ludlow Clayden, chief engineer of gas engine research of the Sun Oil Co., will deal with the matter of water condensation in the lubricating oil, where it originates, its harmful effects and how it may be alleviated. Neil MacCoull, lubrication engineer of the Texas Co., has been conducting an investigation of crankcase-oil dilution causes and effects for many months. He will present the results of this investigation. C. M. Larson of the Sinclair Refining Co. will present a brief discussion and G. A. Round of the Vacuum Oil Co. will present interesting microphotographs of contaminated oil to show the presence of dirt and dust particles. Ralph L. Skinner, who developed the oil-dilution rectifier recently adopted on Rickenbacker models, will present the

[1] See The Journal, January, 1924, p. 136.

The Warren Hotel at Spring Lake
This Is One of Three Fine Hotels That Have Been Reserved by the Society for the Summer Meeting This Month. Spring Lake, N. J., Boasts Two 18-Hole Golf Courses, Many Tennis Courts, Ocean Bathing and Recreational Features without Number. The Complete Announcement of the Summer Meeting Is Printed on This Page

THE SUMMER MEETING

Time and Place

To be held June 24-27 at Spring Lake, N. J., on the Atlantic seashore between New York and Atlantic City. Adequate hotel, sports and meeting facilities. Special hotel and railroad rates.

Tuesday, June 24

Session on Riding-Quality in afternoon. Semi-Annual Business Meeting of the Society in the evening, followed by dancing and entertainment. Demonstrations related to Riding-Quality.

Wednesday, June 25

Session on Oil Dilution and Contamination in morning and continued in the evening. Athletic tournaments start in afternoon. Golf, tennis, trapshooting and baseball. Dancing in evening.

Thursday, June 26

Meeting of the Standards Committee in morning. Annual S.A.E. Field-Day during afternoon. Continuation of tournaments. Session on New Transmission Systems in evening. Grand Ball.

Friday, June 27

Session on Air-Cleaners in morning meeting. Annual S.A.E. Water Carnival in afternoon Finals in golf, baseball, tennis and trapshooting. Meeting closes after dinner.

Hotels and Transportation

Three large hotels. One reserved for parties including ladies. Special trains from Middle West both going to and returning from Spring Lake. Private buses from New York. Low rail-rates.

history of the development of this device, describing the problems encountered, telling about the failures as well as the successes and will include interesting data on engine wear caused by dilution. The latest results of dilution tests made at the Bureau of Standards as a part of the Cooperative Fuel Research project fostered by the Society will be presented by S. W. Sparrow.

Developments in New Transmissions

Thursday evening's session will be concerned with the possibility of improving upon the sliding-gear transmission now used universally in automotive vehicles. Prof. J. M. Nickelsen of the University of Michigan will summarize the situation, describe some of the European and American developments and analyze the possibilities of doing away with transmission gears entirely. An engineer of the Weiss Engineering Association will describe an unconventional universal speed transmission and demonstrate its action. W. A. McCarrell will do likewise with an automatic-shift gear transmission. Other papers are expected.

Air-Cleaners will be the topic on Friday morning. A. R. Squyer, an engineer with the Holt Mfg. Co., will read an extremely valuable paper on the testing of air-cleaners. He will describe test methods tried and abandoned by Holt engineers and will give in detail the test procedure eventually adopted as giving the most satisfactory results. The Society has arranged to bring A. H. Hoffman from the University of California Test Farm to give results of the latest investigations made by that institution on air-cleaning devices of the most recent design. C. P. Grimes, who is now connected with the United Mfg. & Distributing Co., will read a paper on cleaners that function on the mechanical separation principle. P. S. Tice will set forth his opinions on what a satisfactory air-cleaning device should do. L. L. Dollinger, chief engineer of the Staynew Filter Co., will tell why air-cleaners are an essential part of passenger-car equipment.

Two other important sessions are scheduled to be held at Spring Lake. These are the Semi-Annual Business Meeting of the Society on Tuesday evening and the Standards Meeting on Thursday morning. President Crane will address the former meeting and the members-at-large of the national Nominating Committee will be selected. Reports of the Society's activities will be presented. The proposals that will be presented for discussion and approval at the Standards Committee meeting are printed in full in this issue of The Journal on p. 625.

Sports and Social Diversions

Despite the ambitious program of technical meetings and professional activities, there will be plenty of athletic and social diversion at Spring Lake. Two 18-hole golf courses

Special Train Schedule and Connections

Lv.	St. Louis	10:00 p.m. C. T.	Sunday, June 22	Big Four
Lv.	Indianapolis	7:00 a.m. C. T.	Monday, June 23	Big Four
Ar.	Cleveland	4:55 p.m. E. T.	Monday, June 23	Big Four
Lv.	Cincinnati	8:30 a.m. C. T.	Monday, June 23	Big Four
Lv.	Dayton	10:00 a.m. C. T.	Monday, June 23	Big Four
Lv.	Springfield	10:45 a.m. C. T.	Monday, June 23	Big Four
Lv.	Columbus	1:05 p.m. E. T.	Monday, June 23	Big Four
Ar.	Cleveland	4:55 p.m. E. T.	Monday, June 23	Big Four
Lv.	Chicago	8:25 a.m. C. T.	Monday, June 23	New York Central
Lv.	Toledo	2:42 p.m. E. T.	Monday, June 23	New York Central
Ar.	Cleveland	5:25 p.m. E. T.	Monday, June 23	New York Central
Lv.	Cleveland	5:25 p.m. E. T.	Monday, June 23	New York Central
Ar.	Buffalo	9:30 p.m. E. T.	Monday, June 23	New York Central
Lv.	Detroit	4:15 p.m. E. T.	Monday, June 23	Michigan Central
Ar.	Buffalo	9:30 p.m. E. T.	Monday, June 23	Michigan Central
Lv.	Buffalo	9:30 p.m. E. T.	Monday, June 23	New York Central
Lv.	Rochester	11:43 p.m. E. T.	Monday, June 23	New York Central
Lv.	Syracuse	1:30 a.m. E. T.	Tuesday, June 24	West Shore
Lv.	National Junction	8:00 a.m. E. T.	Tuesday, June 24	New Jersey Central
Ar.	Spring Lake	9:30 a.m. E. T.	Tuesday, June 24	New Jersey Central
	Special arrives	10:30 a.m. Daylight Saving Time		

will tempt the wielders of brassie and mid-iron. The rolling surf of the Atlantic will beckon to the bathers. Tennis matches will be played to select a champion. Trapshooting enthusiasts are urged to bring their cannons for the comprehensive program of daily shoots that has been arranged for them. Section rivalry will be keen in the baseball, swimming and field-day events. Movies on the lawn, dancing, fireworks, bridge parties and even our Oriental friend Mah-Jongg will be on duty to pass the hours for Milady and her escort. The spirit and atmosphere of an S. A. E. Summer Meeting just cannot be painted in cold type. Come once and it will take its place on your calendar along with the holidays, your birthday and the all-important wedding anniversary.

Reduced Fares and Special Trains

It will be possible for a majority of the members to travel to the Spring Lake meeting and return for one and one-half times the one-way fare. Certificates entitling members and the immediate members of their families to this reduced-fare privilege will be mailed from the New York office on June 7. Guests of members, who are not members of the Society, may obtain a reduced railroad rate by purchasing summer tourist tickets to Spring Lake. Non-members cannot use the S. A. E. reduced-fare certificates. Special S. A. E trains will transport the middle-western contingent to the Summer Meeting. Arrangements have been made with the New York Central System to route this special train through many of the important automotive centers, as the schedule at the bottom of p. 567 indicates.

Reservations on the S. A. E. Flyer can be made through the representative of the New York Central System in your city. In addition to the advantage of carrying members direct to Spring Lake without change of cars or transfer of baggage, the special train will provide an opportunity to view the scenic beauties of the Hudson River from the west shore. Then there is the additional attraction of traveling with your automotive friends; reunions will be aplenty as the cars are assembled at Buffalo from sundry corners of the industry.

The S. A. E. Flyer is not a one-way train. It will provide the same comfortable and expeditious service returning from Spring Lake on Friday evening, June 27. Leaving about two hours after dinner time, it will reach Cleveland at 12:24 p. m. on Saturday, Detroit at 1:30 p. m., Chicago at 7:40 p. m. and Indianapolis at 8:05 p. m.

FARMERS ARE FAVORABLE TO TRACTORS

Minneapolis Section Speaker Presents Survey Results That Are Significant

Medleys of music and engineering talks served to enliven the Annual Dinner gathering of the Minneapolis Section on the evening of May 8. Three strumping banjoists led by the Section's genial secretary, Phil N. Overman, were the features of the musical program, harmonizing in a manner suited to the tastes and demands of one Paul Whiteman. The speaking program included an extremely interesting interpretation of the tractor situation, two discussions of commercial aviation and a resume of automobile engineering progress.

Dave E. Darrah, advertising manager of the Hart-Parr Co., depicted the present condition of the tractor manufacturing business and talked optimistically of its future. He stated that in 1919 500 companies were organized to build tractors. Of these, 300 actually marketed sufficient tractors to warrant their being listed as manufacturers. Today, 5 years later, only 20 of these firms remain in the business and only 10 of them are actually building new machines; the remaining 10 are simply disposing of accumulated stocks. Mr. Darrah said that the men remaining in the tractor industry must build confidence in themselves and in the ultimate future of the tractor as an essential economic instrument. Farming is becoming more and more a job for brainy men. The modern farmer will farm efficiently with power, planting and reaping in direct relation with the market's demand, retrenching when the demand is limited, yet taking full advantage of a seller's market.

What Farmers Think About the Tractor

As an indication of the present and future positions of the tractor with the farmers, Mr. Darrah cited the following significant result of a canvass of 20,000 tractor owners:

96 per cent stated that they had made definite savings of time and cost by the use of farm tractors
90 percent said that the tractor had enabled them to raise larger crops
85 per cent said that the tractor had eliminated the hired-help problem
90 per cent expressed the opinion that the tractor had done their plowing better than horses
85 per cent used their tractors for jobbing work off the farm and made average earnings of $630 per year in this work
96 per cent agreed that the modern farm tractor is successful in giving continuous service
90 per cent stated that the tractor is a paying investment.

Mr. Darrah stated that this investigation showed that tractors are now being used 75 days per year on an average. Thirty-nine days of this time represents work in the field, such as plowing and harrowing; the tractors are used for belt-power work the remaining 36 days. While a demand for labor-saving devices and machinery exists among farmers at the present time, Mr. Darrah said that 60 per cent of the tractors now being manufactured are used to replace machines that have outworn their usefulness.

W. A. Kidder and M. A. Northrup, of the Northwest Curtis Co., summarized the commercial aviation situation as it exists today. They were both agreed that the future of commercial aviation rests largely on the ability of the aeronautical industry to sell the public on the safety and value of the airplane as a transportation unit. L. Clayton Hill, assistant general manager of the Society, summarized the progress that has been made in automobile engineering during the last year and made some predictions regarding future developments. He impressed the audience with the increasing tendency to introduce science and scientific methods into the design and manufacture of motor vehicles.

In the brief business session preceding the dinner, A. F. Moyer was elected as the representative of the Minneapolis Section on the Nominating Committee of the Society at Spring Lake. J. L. Mowry, who will serve as chairman of the Minneapolis Section for the year 1924-25, assumed his new duties and announced the appointment of committee chairmen who will start immediately on the arrangement of programs for the Minneapolis Section's meetings that will be resumed in September.

THE ENGINEER'S RELATION TO SERVICE

Chevrolet, Ford, Hupmobile and Packard Representatives Give Opinions at Detroit

What engineers can do to help the service man served as the subject for an interesting meeting of the Detroit Section on May 22. Four speakers, two representing the engineer's viewpoint and two that of the service department, presented brief talks. Harlow N. Davock, manager of the technical service department of the Packard Motor Car Co., said that the vote of the public on the service given by a car first reaches the local service manager. He must be educated to assemble the complaints in relation to their importance and transmit them to the factory service manager who in turn must assemble them in relation to their importance and give the true picture to the engineer. Mr. Davock made a strong plea for simplification of automobile design. The shortage of good mechanics and the exacting demands of the motorist, as to both quickness of making repairs and their low cost, make further simplification imperative. In one large Pack-

DON T. HASTINGS

O. E. HUNT

ard service station it was found that 54.7 per cent of the total repair operations covered repairs on the engine and 56 per cent of these were of the "clean carbon and grind valves" classification. This indicates the importance of simplifying all design related to this operation. Constant redesigning of parts has led in many cases to greater simplicity. On the other hand, it has led to heavy inventories of repair parts which, while carried at large valuations, are worth only their equivalent value as junk. Such continual redesigning results in high costs to produce repair parts when they cease to be used in current production.

Engineers can find much useful information in reports of repair parts sales. Reports of current sales of Packard repair parts show that 76 per cent of the sales are represented by 21 groups of parts. In order of importance these groups start as follows: fenders, pistons, gears, front and rear wheels, etc. In 1920, the order of importance was as follows: axles, springs, valve group, cylinders, clutch, etc. Where fenders were twelfth in 1920, they are now in first place; wheels, which were fifteenth in 1920, now occupy fourth place. Effects of traffic congestion are in evidence here. Mr. Davock said that engineers can help the service man by condemning accessories that are either useless or actually detrimental to the performance or the safety of the car when attached by the owner.

In his contribution to the symposium, Don T. Hastings outlined the steps taken when designing a car to fit a particular market. He indicated that it is not always possible for an engineer to design the ultimate in simplicity and accessibility into a car because of limitations placed in his path by cost and market demands. However, there are some inexcusable examples of inaccessibility on the market and Mr. Hastings cited a few. It requires 12 hours to remove and replace the transmission on one make of car; the same operation can be done on another make in the same price class in a little over three hours. It is impossible to remove or replace the piston and rod as an assembly in another make of car; they must be assembled and disassembled in the engine. There is no excuse for the continued use of sod-pans under the engines of some cars; they only serve to increase the cost of engine repairs. Oversize repair parts should be stocked by factories in suitable sizes. This is true not only of pistons and rings; oversize tappets, and valves with oversize stems are examples of necessary additions to the list.

O. E. Hunt, chief engineer of the Chevrolet Motor Co., commented on the increasing attention that is being paid by motorists to operating costs in terms of cents per mile. This attitude in company with a strongly competitive market puts the responsibility on the engineer to reduce these costs. He must look upon the records of car operation in the public's hands as the results of a nation-wide road-test of his designs. It is his duty to see that proper means are provided to get service reports from the field into his hands without their having to pass through the hands of too many non-technical middlemen who will color facts with opinions. Mr. Hunt presented some figures on operating costs based on a 20,000-mile operation of a moderate-priced car carrying full load. The total cost including all overhead and depreciation was nine cents per mile. Fixed costs amounted to three and one-half cents; operating costs, two cents; maintenance costs, three and one-half cents. Fixed costs were based on an annual operation of 10,000 miles and depreciation on the actual resale value of the car after the test was completed.

W. T. Fishleigh, engineer of the Ford Motor Co., said that he believed the average engineer spends too much of his time in the engineering department; he thinks too much of engineering details. Being enwrapped in these details he often overlooks service problems. He knows too much about different designs and is apt to keep trying new ideas instead of sticking to and improving the old ones. When a design is perfected that represents good value it should not be altered unless the change really effects an improvement on the basis of dollar value on wheels. Engineers should study why *not* to make a change as well as why to make it.

FABRIC PANELLED BODY HAS ARRIVED

Its Features and Body Hardware Standardization Are Detroit Section Topics

Enclosed bodies panelled with fabric instead of with sheet metal and a plea for standardization of body hardware, particularly window regulators, served as the topic for an unusually successful body engineering meeting of the Detroit Section on May 8. Great interest was shown in the paper on fabric bodies and it was evident that this method of building closed bodies is no longer regarded as a mere novelty or fad soon to be forgotten. Months of road-testing experience have been had with the fabric body since it was first described in a paper at the 1923 Annual Meeting of the Society.[1] This led the engineers present to discuss this unconventional form of body construction in a more serious way than was done in the first instance.

BODY HARDWARE STANDARDS NEEDED

In his paper on Window Regulators, S. W. Nicholson of the Dura Co. made a strong plea for the standardization of body hardware. Referring particularly to the case of window-lifters, he said that some body development has simplified these units, but that these simplifications had not come about through cooperation between the body engineer and the hardware manufacturer, but have been effected by sheer force of circumstance and good luck. Further simplification can be effected in the future by straight thinking and cooperation between the body and hardware manufacturer. The elimination of extreme turn-unders in body design has straightened out glass-runways. Discarding the jump-the-fence form of window-lifter has greatly simplified the lifter mechanism. The introduction of sashless glass and the use of soft slide channels have helped considerably. The increasing width of window glass in automobile bodies is beneficial to almost any mechanical window-lifting device. Theoretically, the closer the vertical parallels, the better; actual practice contradicts this theory, however.

Greater uniformity in body framework, particularly at the belt-line and lock-board section, is helpful to the standardization of window-lifter construction. In any conventional window regulator rarely are more than 30 component parts to be found. Yet, to serve the demand made upon the Dura Co. by the irregular non-conforming specifications of the buyers of this equipment, 750 parts have to be manufactured. To correct this costly method, a composite picture of all specifications was made to determine to what extent they were dissimilar and to ascertain to what extent a standard specification would serve the maximum number of customers with the least possible hardship to the others. The results were surprising; it was found that many of the differences were of no major importance whatsoever. When it was explained to the body builders that acceptance of the

[1] See THE JOURNAL, February, 1923, p. 213.

standard specifications would result in a very substantial price reduction in the equipment, all were interested and the great majority welcomed the chance of making a saving. As a result, at least 90 per cent of the buyers of this company's equipment have adopted a standard unit in place of the irregular ones previously purchased.

Mr. Nicholson said that if the body engineer and the hardware designer will each forget personal fancies and get down to a definite basis of standardization, greater simplification and lowered costs will result. It is not intended that body beauty or individuality shall be sacrificed, but engineers should be able to agree upon such simple things as handle location and glass dimensions.

In the discussion following Mr. Nicholson's paper, George J. Mercer suggested that service literature should be published to instruct garage men and body repair shops on how window regulator repairs should be made. Mr. Nicholson avoided recommending any particular type of window regulator as being the best, stating that this depended upon the service to be performed by the particular window-lifter under consideration. He said that the problem of building a satisfactory regulator for bus service is a difficult one. Regulators that will stand up on passenger cars will not withstand the rigorous service on buses that are mounted on solid tires. Special bus window-regulators of heavy construction are now being developed for this service. It was predicted that the lever type of window lifter would return to favor because of its quick-action feature. This will be particularly true in the case of the driver's door, where quick operation is essential.

Fabric Covered Body Is Gaining Favor

K. L. Childs

K. L. Childs, president of the Fabric Body Corporation, read the paper that discussed the development and progress of the fabric body. Mr. Childs said that the attitude of most people who viewed the first fabric body at the time of the 1923 New York Show was one of skepticism. It was very evident to those who demonstrated this type of body in the 1924 Show that the public had accepted the principles of the fabric body and that a desire to purchase bodies of this type rather than to look upon them as a novelty existed. The designers of the fabric body feel that this type of construction was on trial during the past year. To prove its serviceability, the first fabric body has been driven over 20,000 miles of actual touring mileage under all kinds of road and climatic conditions. The result has apparently been acceptable to even the more skeptical engineers. Several car manufacturers have built fabric bodies in their experimental departments and these models are being subjected to road-tests. From the interest shown it is evident that in the near future this type of construction will find its place in standard lines of production.

One of the outstanding features of the fabric body construction is the increased speed it effects in production. Two departments of modern body shops are eliminated when fabric is used to cover the bodies instead of the customary metal panels. These are the paint shop and the metal shop. A conventional form of wood framing is produced as the foundation for the fabric body. This is ironed according to standard practice and rabbeted in all panel openings to receive the ½-in. mesh No. 19 gage galvanized wire cloth. Several additional strainers are installed to hold the wire out to the proper curve and give the necessary contour to the bodies. After the application of the wire mesh, two layers of cotton wadding are applied and forced into the wire mesh by stretching a heavy sheeting or canvas over the wadding. After the doors have been properly fitted, they are removed and completely trimmed at the bench. At least two men are able to apply the outer fabric at the same time, while a third may be applying the interior trimming. The time saved in this final operation is very evident when compared to the final finishing of a painted metal body. The possibilities of producing fabric bodies on a modern production assembly line are almost unlimited. One plant has allotted a space only 60 ft. square for the complete trimming of 50 bodies each day in line production. The finished bodies will be shipped on the same day they are delivered from the wood shop.

Fabric Body Advantages

It is claimed by Mr. Childs that every fabric body built to date has been more quiet than an equivalent metal body, eliminating to a great extent the drumming and rumbling sounds in the interior. Fabric bodies have averaged from 25 to 110 lb. lighter in weight than a corresponding metal body of equal quality. One of the most attractive features of the fabric body from the owner's standpoint is the ease with which it may be cleaned as compared with the average painted body. This is due to the specially constructed fabric used, the coating of which is hard and withstands abrasion, retaining its luster and being readily cleaned without frequent washing. All panels are made in sections, thus making it possible for each individual section to be removed without disturbing any of the interior trimming and facilitating the repair of any damaged section. This last feature has led insurance underwriters to insure fabric bodies at a lower cost than metal bodies.

Many questions were asked Mr. Childs during the discussion and his answers will be summarized in the following paragraphs. He said that the Childs' form of fabric body must not be confused with the Weyman system that is arousing interest abroad. The Weyman body is built with an extremely light wooden framework that is flexible and weaves with the chassis. The Weyman body merely acts as a cover over the passengers, the passenger weight being carried directly on the chassis since the seats are built on the chassis frame rather than into the body structure. The Childs' type of body follows conventional construction with the single exception that a fabric covering is used instead of metal panels. While it is possible to produce the fabric with colored coatings, Mr. Childs did not believe that this would be done as long as a general demand for the black finish prevailed. He said that several kinds of wire mesh have been tried but the 19 gage, ½-in. mesh is the only type that does not cut the wadding. It has not been found necessary to make the body wood construction any heavier due to eliminating the metal panels when fabric covering is used. Strap irons are used in joining important wooden structural pieces. Practically no objection has been raised by automobile buyers to the grained finish of the fabric materials as compared to the conventional smooth surface of a painted body.

Fabric Bodies May Lower Costs

Mr. Childs made the statement that fabric-covered bodies could be produced at least 15 per cent cheaper than those using painted metal panels. No attempt has been made to build an open body of the fabric construction, largely because too much interest has been shown in the closed type to permit of this investigation. It is recommended that the wire mesh used in this construction be either galvanized, painted or shellaced. If put on without protecting the surface of the wire, the mesh is likely to corrode. Rust-proof tacks and galvanized staples are used in attaching the wire and the fabric. While he did not recommend fabric fenders as a production proposition, Mr. Childs called attention to the fact that they do not rattle or rust and he expressed a strong personal preference for them.

The fabric material is applied to the body in a dry condition. It is not necessary to stretch it over the body with any great force. Wrinkles are avoided by having the proper

amount of curvature in each of the panels. Fullness is removed by increasing the curvature of the panels or making other slight changes in the design. Unevenness of the panel surface is avoided by the use of the two layers of wadding and the canvas covering which serve as the foundation for the fabric covering.

REFINISHING OF AUTOMOBILE BODIES

Merits of Varnish and Duco Compared as to Time of Application and Durability

L. VALENTINE PULSIFER

Two papers on the refinishing of automobile bodies furnished the topic for the meeting of the Metropolitan Section, held at the Automobile Club of America, New York City, on May 15. The first had reference to refinishing operations with varnish and the second with Duco, the authors being L. Valentine Pulsifer, chief chemist, Valentine & Co., New York City, and O. H. Briggs, special representative for sales promotion, E. I. du Pont de Nemours & Co., Wilmington, Del., respectively.

Dr. A. H. Sabin, consulting chemist of the National Lead Co., to whom the meeting had been turned over by Chairman Myers, held the interest of those present, while introducing the speakers, by relating some of his early experiences in the varnish and paint business, and by describing how Lawson Valentine came into possession of a little varnish factory on the Charles River 47 or 48 years ago and engaged C. S. Homer as the first chemist to take up professionally the commercial manufacture of varnish.

The chief reason for many failures of the varnish used in refinishing cars, said Mr. Pulsifer, is ignorance on the part of the manufacturer, the automobile company that specified it and the owner who proceeds to scrub the paint off or remove it with various applications. He then showed with charts the right and wrong ways of engineering a paint structure. After describing the qualities of varnish that make for durability, he said that it was necessary to decrease the elasticity of each coat from the primer to the body color and then to increase each succeeding coat from the body color to the final finishing varnish to obtain long life. When more than one finishing coat is used, the outside one should be the most elastic; the general rule for finishing a car so that refinishing later may be successful is to use the minimum number of coats that will give adequate protection and suitable appearance, and coats that have the maximum elasticity compatible with the function they are intended to fulfill.

The usual complete painting system, Mr. Pulsifer said, consists of five basic types of material: (*a*) priming, (*b*) surfacing, (*c*) coloring, (*d*) rubbing and (*e*) finishing. The finishing-varnish protects the undercoats from the elements that tend to break down the structure. On metal smooth enough to dispense with all surfacing materials the system should consist of six basic coats: (*a*) the primer; (*b*) the elastic ground-color, some colors requiring two coats; (*c*) color-varnish mixed with 48-hr. rubbing-varnish; (*d*) color-varnish mixed with one-half 48-hr. rubbing-varnish and one-half first coat finishing-varnish; (*e*) first-coat finishing-varnish; and (*f*) final finishing-varnish. Applying this system would require from a week to 10 days.

The controlling factors in the selection of the type of refinishing system to be used are cost, time, the desired appearance and the desired durability. To meet the demand for a low-price high-speed high-gloss durable repainting job, spar varnish enamel has been produced. This combines simplicity of application, speed of drying, solid and brilliant color, great durability and resistance to abuse, and enables the repair shop to do high-speed work at a very low price. This enamel takes the place of the usual color, color-varnish and finishing-varnish coats.

In introducing Mr. Briggs, Doctor Sabin told of a professor in Vermont who, about 40 years ago, produced a wonderful elastic material by treating cotton with nitric acid and dissolving it in alcohol and ether. This has been known for a long time as collodion. The difficulty was that, whereas shellac varnish contains from 2.5 to 4.0 lb. of solid matter per gal., collodion material would take only 7 or 8 oz. per gal., because of what is called false body. About 37 or 38 years ago, he said, Frederick Crane began making solutions of collodion for lacquers and putting them on cloth, forming a coated fabric and artificial leather. The du Pont Company found that oxidized linseed oil could be dissolved in the solution, also certain varnish resins that had been previously dissolved in other solutions. These coatings were applied first to furniture and then to carriages and automobiles. Shellac varnish, being only a solution of shellac resin in alcohol, dries by oxidation; the coatings made by the du Pont Company dry by the evaporation of the solvent. The first use of spray sprinkling for painting purposes, he said, was made by George D. Milligan, a painting contractor of Chicago, who painted the World's Fair buildings in 1893 with an ordinary lawn sprinkler attached to a hose.

In opening the case for Duco, Mr. Briggs remarked that although headache powders, explosives, dyes and perfumes come from coal tar, it is not usual to expect that cotton will produce a lustrous, long-wearing, beautiful protective finish for motor cars; but cotton is the basis of Duco, a material of the nature of pyralin from which brushes and combs are made; similar materials also are used for the transparent windows of automobiles and for the Fabrikoid imitation-leather seats.

Pyroxylin enamel was first applied to automobile bodies in 1914 at the Arlington, N. J., plant of the du Pont Company but was not successful because the enamel was entirely too brittle, on account of the large amount of pigment and the lack of sufficient binder in the material. In 1919 another attempt failed because of insufficient binder and unsuitable coloring material. In 1920 by mixing pyroxylin enamel with a clear lacquer, a material was produced that endured for a year without great deterioration and in the fall the du Pont Company began the production of a lacquer of light viscosity; but it was not until 1922 that the material was brought to a point that was considered satisfactory to the automobile industry.

In applying Duco the old paint should first be removed from the surface to be refinished. This is accomplished best by some chemical paint-remover, such as Aloka, a caustic solution, the action of which is accelerated by hot water and neutralized by cold water. Other paint removers can be used but it is difficult to remove them after they have been used. By the Aloka system, old paint can be removed from a medium-size car in 2 hr. Care must be taken to remove all traces of chemical from the edges of the molding, the fender joints, and the like, by washing with gasoline and sanding with fine sandpaper. When ordinary surfacing materials are used prior to the application of Duco the surface coat must be allowed to oxidize thoroughly, because Duco will dissolve unoxidized linseed oil.

In surfacing a car with pyroxylin materials, the first step is the application of a light spray coat. The second step is spot-spraying to fill file marks and other defects completely. This is followed by a heavy spray coat of material thinned as for priming. After air-drying for 3 or 4 hr. the surface is rubbed with dry sandpaper to remove particles of foreign matter collected while drying. The second surface coat is then applied, allowed to dry overnight, and rubbed to a surface with sandpaper and water or gasoline. Incompletely filled spots should be filled with a small spot-spray gun, using the first-coat Duco material. The next coat should be

heavy and should be allowed to dry overnight and then rubbed to a surface. When the proper surface has been obtained a top coat of equal parts of gloss and Duco, thinned with an equal amount of thinner, is put on. A high gloss can be given by rubbing with Simon's cleaner followed by a washing with Simon's wax.

When the paint has been removed from the wheels and the wooden parts, they should be sprayed with a 6 to 4 mixture of Viscolac intermediate and thinner. This has better adhesion on wood and also prevents the absorption of moisture into the wood during the rubbing operation.

Window glass may be protected from the spraying and cleaning may be facilitated by applying grease to the glass, care being taken to prevent any of the grease from getting on to the parts to be sprayed. Duco materials can be easily removed with the grease after the job has been finished. Striping materials over Duco, before the application of wax, can be protected by Sheratone, which can be brushed in over a stripe in the same way as varnish. It dries to a lower degree of luster than varnish and gives equal protection to the stripe.

Among the advantages claimed for Duco for refinishing are, that it

Has a quicker turnover
Has a larger percentage of profit per job
Is less seasonable because of the shorter tie-up of cars
Aids in selling refinished jobs to customers
Requires less skilled labor
Requires less floor-space because of the shorter time needed to finish
Eliminates the rejection of jobs at the final inspection because of foreign matter settling on the finished surface
Does not show off-color when defects in the finish are patched after the job has been finished for some time
Makes it possible for the refinisher to give a guarantee without risk
Obviates a come-back by the owner because of defects for which he is responsible
Opens a profitable business in coloring Duco jobs after 1 or 2 years' service
Eliminates the cut-price competition of alley shops due to the difference in skill in the application of Duco
Offers something new in the way of a finish for those who have not been customers for repaint work
Will attract the business of professional men who do not have their cars refinished because of the long time usually required
Furnishes a practical finish for cars in service in the salt air of the seashore
Opens a field for use on trucks when speed of application and durability are of great importance

Replying to questions, Mr. Pulsifer explained that, inasmuch as the oleoresinous types of resin dry by oxidation, increased temperature will hasten chemical action, and that when heat above 120 deg. fahr. is applied, it is necessary to condition the air by controlling the humidity, otherwise the surface oxidation will be too rapid and will produce what is known as case-hardening. When 120 deg. fahr. shows on the dry bulb, the wet bulb should show about 90. A quick way of refinishing is to use spar-varnish-type enamel, which is high in elasticity, extremely resistant to all kinds of abuse and dries very rapidly. Two or three days is ample time for two coats of this varnish and even quicker time can be made if forced drying is available.

On assembled jobs where parts are received from several makers, unless the kind of primer used is known, the safest way is to remove the old primer. Organizations should specify the kind of primer to be used so that the work can be continued from that point. The chemical rays of the sun are the most destructive but the heat of the sun has very little effect on paint or varnish. In California the sunlight is particularly severe. After sunlight has begun the destruction, moisture and alkali are the chief offenders in the breakdown.

A sealer is a coat of material similar to a wood primer, going over the roughstuff or surfacer after the material has been rubbed down ready for the subsequent coats and sealing the pores of the material; it is long in oil and very elastic. Combining the maximum sealing effect with a solid covering coat would require a material that is too heavy to harden through properly and that would be likely to upset the smoothing and elasticity curve of the work; but it is possible to use a primer that will have a small sealing effect.

In comparing paint and varnish with Duco, Mr. Sprague asserted that from a service standpoint it was a question of how best to satisfy the owner of the car. Owners usually call for the maximum speed of delivery. Good finishers, he said, are becoming scarce; on the other hand, in 3 or 4 weeks a man can be taught to do a job with Duco that will compare favorably with that done by a man who has spent several years working with varnish.

Duco, he said, was tried in his shop 3 years ago, in an attempt to save expense and find a quicker method of doing the work. A car turned out then is still out, after withstanding all sorts of weather conditions, and today looks as well as or better than when it was finished. Duco doubles the floor space of the shop because a car is in it only half the usual time.

A man whose car had been in collision with a trolley-car brought it in on a Thursday; it was delivered to him Saturday morning and the painting on the damaged parts matched the rest of the car perfectly. If the surface of a car is good, if the varnish is of a light character and if a light first coat of Duco is applied, it is fairly safe to apply Duco over paint or varnish.

Referring to the questions submitted on the cards, Mr. Briggs said that when Duco is applied to a smooth metal surface like cold-rolled steel, the surface should first be roughed by sandblast or fireblast to give sufficient anchorage and adhesion. Duco has no advantage as compared with black japan work; in small amounts Duco might be better, in large amounts black japan would be better.

The fumes from Duco spray are no more injurious than are those from paint-type materials. But they are not pleasant and can be removed by exhaust fans. By shooting the gun into a booth in the direction of the flow of air the workman will not have to breathe the fumes. Duco will withstand the action of salt air and has been used satisfactorily under the alkali conditions of the Southwest. It should not be applied directly to the metal but should be used with a metal primer of the paint type and a priming coat of pyroxylin roughstuff. High temperature does not decrease the drying time appreciably. It will withstand 600 deg. fahr. for a reasonable length of time and will withstand 250 deg. fahr. over a period of months or years. There is no satisfactory method of applying Duco except with a gun. Striping and lettering will hold satisfactorily on Duco-painted materials. With regard to the comparative costs of Duco and paint, Mr. Briggs said that it was possible to do either as expensive a job as with paint or one that would compare with the cheaper types of painting, depending on the quality of the work desired. In general, the cost of Duco should be considerably less than that of paint.

Business Session

A lively business meeting and dinner preceded the opening of the technical session. Arguments for and against the automatic form of Section membership advocated by some of the officers of the Metropolitan Section were heard. It was evident from the general discussion that opinion was divided and no formal action was taken on this important matter of Section policy as such. However, the following resolution that grew out of the general discussion was unanimously approved:

Resolved that we, the members of the Metropolitan Section, strongly request the Council to take some action that will relieve our Section officers of bill collecting.

WASHINGTON SECTION

Washington Section devoted its meeting on May 2 to a discussion of business matters and to the introduction of its new officers for the 1924-25 Section year The retiring chairman, C. H. Warrington, spoke briefly and the incoming chairman, A. W. S. Herrington, talked about plans for the Section meetings during the coming year. Mr. Herrington was elected to represent the Washington Section on the Nominating Committee of the Society at Spring Lake. Washington Section activities will be resumed in September.

CRITICAL DISCUSSION OF BUS DESIGN

Better Brakes, Lighting, Ventilation and Heating Must Be Provided

Motorbus design and operation were discussed most comprehensively at the meeting of the Pennsylvania Section on May 13. The basis of the discussion was an excellent paper by A. E. Hutt, general manager of the Philadelphia Rural Transit Co., which is printed in full in this issue of THE JOURNAL starting on p. 591. The following paragraphs report some of the more salient points brought out in the discussion of the paper.

A. E. HUTT

Referring to his system of unit overhaul for motorbuses, Mr. Hutt said that it is difficult to set the exact mileage at which any particular unit should be overhauled until experience with it in operation has been had. The mileage should be set at the highest limit that the unit will stand with a reasonable expectation of no mechanical failures on the road. Mr. Hutt has set the mileage for engine overhaul at 50,000 miles; no figure has been determined for transmissions as yet; clutches are overhauled on a 50,000-mile basis. A great difference will be found in units, however, for in the case of clutches Mr. Hutt mentioned that one type he is using must be overhauled every 10,000 miles.

BETTER BRAKES NEEDED FOR BUSES

Asked what item in bus operation gives the greatest amount of trouble, Mr. Hutt replied that it was the brakes. He is looking forward to a radical change in brake design for buses. Bus brakes must be far more efficient and far better built than those used on touring cars. The possibilities for four-wheel brakes on buses as a means of securing additional braking area are great. In such a design Mr. Hutt would utilize all the area on the rear wheel brake-drums for the service brake and would arrange to have the holding or emergency brake on the front wheels. This would allow all of the brake-drum area on the rear wheels to be given to the service brake, hence increasing its area, reducing the unit pressure on the lining and cutting down materially the frequency of brake adjustment and relining.

The question of maximum schedule speed for motorbuses was discussed. Mr. Hutt said that this depends on the type of equipment and the size of the engine. It also is related to the volume of traffic on the route and the number of stops that have to be made; the type of road and the grades also have an influence. R. E. Fielder said that the Fifth Avenue buses in New York City operate on a schedule speed of about 9 m.p.h. but this must be reduced below 57th Street on Fifth Avenue to about 4.3 m.p.h. Mr. Hutt said that the buses in Detroit operate at an average speed of a little over 10 m.p.h. He hopes to maintain an average speed in Philadelphia of 12 m.p.h. and is equipping the buses with 100-hp. six-cylinder engines for this purpose. Mr. Fielder commented that speed is something that has to be handled conservatively, as a bus operator must minimize his accident account, an appreciable item in operating cost.

UNIQUE SIGNAL FOR ONE-MAN BUSES

In discussing the operation of double-deck buses by one man, Mr. Hutt described an interesting device used to inform the driver of the movement of the passengers on the upper deck. On the type of one-man bus in question, the seats on the upper deck are covered but the aisle-way is not. As long as the passengers are seated the driver may be sure that no danger of any of them being struck by an overhead obstruction exists. If they are standing in the passageway he knows that this danger exists. A light is arranged in these buses so that it projects a ray down through the center of the aisle on the upper deck, this ray of light striking a reflecting mirror in a periscope that illuminates a signal in the driver's compartment. When passengers are standing in the aisle-way, they obstruct the passage of this ray of light from the front to the rear of the bus and the driver immediately brings his bus to a stop until the signal is clear.

One of the members asked whether it is not true that the maintenance cost of buses constitutes the greatest percentage of the over-all cost of operation. Mr. Hutt replied that it does not by any means. In the case of the Detroit bus operation the total cost of maintenance of the buses, both bodies and chassis, including all the overhauls, is less than 3 cents per mile. In comparison with this it must be noticed that the cost for platform help, that is, conductors and drivers, is 14 cents per mile. This indicates how important it is to maintain as high an average speed as is consistent with safe operation.

PNEUMATIC TIRES NOT SUCCESSFUL ON DOUBLE-DECK BUSES

Mr. Hutt said that a fair year's mileage would be about 50,000 miles for a double-deck bus operating in a large city. Pneumatic tires have not been used successfully on double-deck buses to date. Mr. Hutt does not mean to say that they may not be developed satisfactorily in the future, but he is not in favor of them at the present time. Bus lighting failures could be greatly reduced if the bodies were properly wired in the first place. It was rather amusing to hear Mr. Hutt's statement that 90 per cent of the bulb renewals were not due to burned-out lamps but due to the passengers having stolen the original bulbs. Unfortunately these fit the head-lamps of automobiles.

R. E. Fielder, chief engineer of the Fifth Avenue Coach Co., did not agree with Mr. Hutt's suggestion that motorbuses be overhauled by a unit system. He did not believe that this would allow the economic scheduling of work in the shop so that it could be taken care of by the minimum mechanical force and with the minimum floor space. It would not permit the distribution of supplies over an even period of time. A proper design of motorbus should be arranged so that every unit will have a life related with the other units in the chassis. To be done economically, the annual overhaul should be carried out at a time when all units are in need of attention. It is not good design to have an engine that will operate 50,000 miles without overhaul and assemble with it a transmission that may run another 3 months without any repairs. If both units are overhauled at the end of 50,000 miles, 3 months' life of the transmission have been wasted. On the other hand, if this overhaul of the transmission is not made at the same time as that of the engine the parts must be brought in again 3 months later to do additional work on the transmission.

UNIQUE SIGNAL FOR ONE-MAN BUSES

Engine types for bus use were discussed at some length. Mr. Fielder stated that the Fifth Avenue Coach Co. has been favorable to the Knight type of engine because it eliminates all trouble due to improperly seated and adjusted valves. Mr. Hutt said that at one time he had contemplated making

a change to an overhead-valve engine so that he could use interchangeable heads for replacement purposes when valve-grinding had to be done. However, he has since had further experience with Knight engines that are of an improved type and he is most enthusiastic about them. He spoke of having run 10 buses for 30,000 miles without touching the engines so far as the valves were concerned.

W. E. Martin, superintendent of automotive equipment of the United Railways & Electric Co. of Baltimore, made several interesting comments. His organization is operating 34 motorbuses and 3 trackless trolleys. Brakes have given their organization the most trouble so far as maintenance and repairs are concerned. Considerable trouble has been experienced with the trackless trolleys due to the design of the vehicle. It is true that improvements have been made in other trackless trolleys that have not been incorporated in the Baltimore units. However, Mr. Martin believes that the buses are more flexible in operation than the trackless trolleys. He said that one other item of bus design, namely the lighting installations, had caused trouble as great as that experienced with the brakes.

Bus Specifications Drafted for New Jersey

A discussion that will be of great interest to motorbus designers was presented by Robert Burns, traffic supervisor of Camden, N. J. He presented some of the more interesting points incorporated in the motorbus specifications that have been drafted by the bus supervisors of the Board of Public Utility Commissioners of New Jersey. With reference to body specifications, the maximum overall length of the body must not exceed 21 ft. and the bumper should not extend more than 4 in. beyond the body proper. The minimum of length shall be 16 ft. The body width shall be a maximum of 7 ft. 10 in. outside measurements and a minimum of 7 ft.; the inside height from floor to ceiling must not exceed 6 ft. 6 in. and the minimum shall be 6 ft. 4 in. The specifications recommend that a partition be constructed of wood and glass to separate the driver's seat from the passenger compartment. This is added as a safety precaution since it prevents conversations between the driver and the passengers.

Under the New Jersey specifications, all buses must be equipped with at least four ventilators of a suitable type to be adopted by the different cities subject to approval by the Board of Public Utility Commissioners. Mr. Burns stated that the ventilator system is a very important part of bus equipment. Half of the buses that are constructed today do not have provision made for proper ventilation; they are often filled with foul air and their windows steam up.

Another clause in the specifications will require that grab-handles be located inside the vestibule of the bus and be bolted in place. Placing the grab-handles inside the bus prevents passengers from attempting to board a vehicle while it is in motion. The New Jersey specifications state that there shall be a clearance of 24 in. in the opening of all entrance and exit doors of a bus.

Overloading Discouraged by Limiting Overhang

Mr. Burns called attention to one important item in the specifications which is causing the vehicle administrators some concern. This relates to the distance that a body shall extend beyond the chassis, often known as the overhang. This dimension is important because it tends to prevent the mounting of large bodies on chassis of inadequate capacities. Independent operators frequently buy a bus of small capacity and later replace the body with one having a large overhang to increase their revenue. The usual result is a bus that is unsafe and should not be permitted on the streets. The New Jersey authorities recommend that the chassis be the full length of the body and extend to the body's sills. R. E. Fielder stated that he believed this specification to be too stringent. He indicated how it would not be bad engineering to have a dimension of 98 in. from the rear axle to the extreme rear end of the body of a double-deck bus with a rear stairway. A. F. Masury, who served as chairman of the meeting, said that he endeavored to fix the overhang not to exceed 60 in. from the rear-wheel center.

Mr. Burns said that the new specifications required that all buses be equipped with window guard rails and with emergency exit doors. In addition to his criticism of the ventilation of bus bodies, Mr. Burns also stated that the lighting is poor and the heating systems generally are inadequate. Noisy brakes are the cause of considerable annoyance and Mr. Burns predicted that unless the manufacturers of buses take steps to correct this fault, cities will adopt ordinances preventing the operation of buses with noisy brakes.

G. H. Scragg called Mr. Burns' attention to the fact that body specifications such as those drawn up by the New Jersey authorities will tend to increase the cost of bus bodies and chasses to the New Jersey operators. Bus body manufacturers attempt to supply bodies that will suit the average demand of the entire Country and when one State specifies special body features for bus bodies used within its borders, it means that none of the advantages of quantity production will accrue to the purchasers of those bodies.

Rapid Loading and Unloading Important

R. E. Plimpton, associate editor of *Bus Transportation*, called attention to the importance of reducing the loading and unloading time of motorbuses to increase their economic usefulness. He said that the increased time of loading double-deck buses due to the passengers having to climb a stairway to the upper deck was a disadvantage. He wondered whether single-deck buses with entrance and exit doors might not be used to better advantage. The matter of door location and the number of doors is an important item of design worthy of careful consideration. Some of the municipal buses operated in New York City have double-width doors so that two streams of passengers can pass through them at the same time. Charles Froesch of the International Motor Co., contributed an interesting discussion and agreed with Mr. Plimpton in some respects. He said that while it is more economical to use double-deck two-man controlled buses during the peak load, standard 25-passenger buses on pneumatic tires would prove more economical for non-rush periods and would expedite traffic.

CHICAGO MEMBERS VISIT REFINERY

Busy Day Starts with Golf Tournament and Ends with Fuel Meeting

As the closing event in its most successful year the Mid-West Section held a lively all-day session on May 16 which included golf at the Hammond Country Club in the forenoon, a visit to the Whiting refinery of the Standard Oil Co. of Indiana in the afternoon, dinner at the Engineers' Club, Chicago, and an address by Thomas Midgley, Jr. at the evening meeting. Several members of the Indiana and the Milwaukee Sections were present as guests.

Thomas Midgley, Jr.

By sticking to his game until he almost missed lunch, Flemming, of the Westinghouse Electric & Mfg. Co., captured first prize from 28 competitors in the golf tournament. W. J. Buettner, A. D. MacLean and Dr. Bransky won a dozen golf balls apiece for the best scores in their classes and numerous other unofficial and unrecorded rewards changed hands.

Because of their devotion to golf and lunch, members were late in starting on their tour of the Whiting refinery, but still spent nearly 2 hr. studying the evolution of gasoline,

grease and lubricating oils under the efficient guidance of E. P. Brown, of the Research Laboratory.

After the customary dinner at the Engineers' Club the assembly was highly entertained by Thomas Midgley, Jr. who discussed the trials and tribulations attending the development of anti-knock fuels. The subsequent discussion brought out many interesting facts concerning the performance and remarkable popularity among motorists of gasoline treated with tetraethyl-lead as an anti-knock material. Demand for the ethylized fuel has been so great as to tax the facilities of the suppliers and actually resulted recently in a temporary suspension of sales in the Chicago district. Motorists are now using in the neighborhood of 1,000,000 gal. of ethylized gas daily. Mr. Midgley predicted that engine compressions will be raised eventually to take full advantage of the anti-knock properties of the fuel and also to increase fuel economy and improve engine performance. He believes that 6½ to 1 compression ratio will be the maximum that can be used practicably. Tetraethyl-lead does not retard carbon formation, Mr. Midgley said. It did cause some trouble at the start by forming a deposit on the exhaust-valves but this difficulty has been eliminated by introducing additional chemicals into the solution which counteract this effect. With the latest material only a slight effect of reddish discoloration of the valve is noted. Tetraethyl-lead is in a state of perfect solution when mixed with gasoline and remains effective after the gasoline has been in storage for periods of from 6 months to a year.

Officers and members of the Mid-West Section joined in expressing their appreciation of the courtesies extended them by the Standard Oil Co. of Indiana during the extremely interesting educational trip through its Whiting refinery. This being the final meeting of the year, the excellent reports of the retiring officers were read and accepted with due thanks and congratulations. The following officers were installed for the coming year: Chairman, Frank C. Mock; Vice-Chairman, Robert E. Wilson; Secretary, Prescott C. Ritchie; Treasurer, Walter J. Buettner.

CLEVELANDERS DESIGN SPORT MODEL

Judging from the advance literature that heralds the Cleveland Section Good Fellowship Day, June 7, this gathering may be likened to a three-ring circus running rampant midst an old-fashioned family picnic. John Younger's genial personality can be seen merrily spreading itself between the lines of an impressive announcement that reaches the New York City office. Clyde Pelton, Leo Williams, Buckwalter, Parker, Wooler and numerous others are to guide the proceedings, it would seem. There is to be golfing, good and bad; running; jumping; tennis and, lo and behold, a beauty contest!

Clevelanders are envied the thrills of these undignified carryings-on. It is good advice to those in the vicinity of the Ohio metropolis to hie themselves and families to the Cedarhurst Country Club, 1 mile east of Wickliffe on Euclid, say the posters, on June 7, starting at 2:30 in the afternoon.

NATIONAL SERVICE CONVENTION

Many Phases of Maintenance Work Discussed at Detroit Sessions

About 800 men who are engaged in automotive maintenance work in various parts of the Country attended in Detroit last month the sessions of the National Automotive Service Convention held under the auspices of the National Automobile Chamber of Commerce in cooperation with the Society of Automotive Engineers, the Motor & Accessory Manufacturers' Association, the National Automobile Dealers' Association, the Automotive Equipment Association and Service Equipment Associates. Many subjects were discussed by authorities, including definition of service policy from the dealer's standpoint, the training of mechanics, shop equipment, the proper fitting and adjustment of component assemblies of automobiles, the relations of the engineering and the service departments, heat-treatment of alloy-steel, engine lubrication and accounting and selling methods.

The sessions were ably conducted by the presiding officer, F. A. Bonham, general manager of the Parts and Service Division, Durant Motors, Inc., and chairman of the National Automobile Chamber of Commerce Service Committee. Mr. Bonham said that the prime purpose of the meeting was to develop greater interest in the servicing of motor cars and that he hoped that the information presented would be reflected in better service. Alfred Reeves, general manager of the National Automobile Chamber of Commerce, recorded evidence of the higher appreciation that has been evinced of the importance of service in the automotive industry. He said that service ranks at least equally with production and selling. Obviously, satisfactory maintenance of the many millions of automobiles running in this Country constitutes a vital phase of the industry's progress.

What the Public is Entitled To Expect

In the absence of General Manager Vane, of the National Automobile Dealers' Association, Assistant Manager Shaw of that organization presented a statement prepared by the former on the subject of what the public is entitled to expect in service. Little agreement is found among car users on this matter, there having been great lack of definition of policy on the part of car manufacturers in this connection. Mr. Vane made it plain that the problem had been given inadequate attention. Two fundamental questions that must be answered are: What will repairs cost? How long will it take to make them? Ninety per cent of the dissatisfaction over bills for repairs is due to charges for labor.

Mr. Vane said that few dealers have cared what happened in their service departments so long as it did not involve trouble in their salesrooms. No definite policy has been pursued in the selling of new cars. A great difference is noticed between what is contained in the standard 90-day warranty and what the purchaser thinks it means. The public is entitled to a declaration of policy regarding automobile service. In Mr. Vane's opinion this policy should be based on the setting of prices to include only cost plus overhead plus profit; the list price should not include a trading allowance for used automobiles or a margin for free service; the dealer should charge for any maintenance or repair work done on the vehicles; and this work should be done efficiently, at a fair price to the customer and at a profit to the repairmen, by the most skilful mechanics that can be obtained, with standard repair parts and by the latest and most scientific tools and machine equipment available. The car-owner is not entitled to free service, but he is entitled to service under the best conditions. No charge should be made for work required as a result of faulty material or workmanship, inincluding labor charge.

The average life of an automobile is 6 years or more. The industry is just entering its replacement era. Competition will regulate the price of cars to a greater extent than in the past, and maintenance service rendered will be "the thing."

The Training of Mechanics

J. C. Wright, director of the Federal Board for Vocational Education, presented much valuable information based on his long experience. His subject was, The Selection and Training of Mechanics.

In discussing what can be done to reduce expense for repairs, Mr. Wright remarked that the art of tire-making has advanced so greatly that it is not now economical to repair tires. In general, much needs to be done to improve service. The average repairman of today is not trained properly to diagnose and remedy car troubles. The supply of good men being short, the turnover of employes at given shops is too great. Mr. Wright feels that it is fundamentally necessary to have conscientious workers. The opportunities for the concealing of poor workmanship are many. Other needed qualifications are proper physical and mental characteristics and ingenuity or resourcefulness. Men who have had considerable responsibility in such fields of work as inspecting

boilers or elevators are good candidates for positions in automotive service departments.

To provide one good mechanic for every 100 cars, there should be available two or three times as many well trained men as are now available. With respect to schools, the nature of the teaching is the most important thing. The teacher should be skilled as a master workman and have had instructor training. By Congressional appropriation $1,000,000 is allotted annually to the States for use in training teachers of mechanics in all trades. Excluding consideration of tire repairs, Mr. Wright specified the following five major classifications in the maintenance field; general repairmen, electrical service-men, battery service-men, owners and operators, and foremen and inspectors. In the automotive industry the responsibility of the foreman is very great. The speaker also emphasized the fact that successful training in any community depends upon the observance of the idea of cooperation. The public schools cost $2,000,000,000 a year. They must be looked to more and more for assistance in the general solution of the automotive maintenance problem. Meantime over 500,000 men are attending vocational schools. The leaders engaged in automotive work in various localities should confer with the public school superintendents with a view to helping the men who need training but do not know how to get it. At present the average duration of employment in the automotive field is 7½ years.

Shop Layout and General Equipment

E. M. Young, of the advisory staff of the General Motors Corporation, discussed the application of certain fundamentals of the service business relating to shop layout and equipment. A good merchandiser not only displays his wares in a neat and attractive manner but places them within his establishment so that they are easily accessible to his customers. Moreover, he arranges his building so that he can receive, handle, store and deliver merchandise in a manner that will soon gain for him the reputation for good service.

Mr. Young showed lantern slides of a number of floor plans of buildings on lots 80 ft. wide by 150 ft. long and also views of stockrooms and shop installations. The subject of service tools and equipment is one of increasing importance to every one connected with the automotive industry. The development in this field is years behind that of manufacturing equipment. Mr. Young divided service tools and equipment into two broad classifications; those common to automobiles generally, such as small tools, arbor presses, electric drills and jacks; and those special to respective makes of car, these being developed usually under the supervision or with the approval of the car manufacturer, to do specific work in the least time. The car manufacturer should maintain in his service department a technical division charged with the duty of keeping in close touch with service problems in the field and the development of time-saving tools and methods at the factory, as well as at service stations.

Fitting and Adjustment of Component Assemblies

The session held on the second day of the convention was devoted to a discussion of the proper methods of fitting and adjusting sub-assemblies of automobiles. D. Andrew, service manager of the Continental Motors Corporation, gave information on recommended types of tool or fixture, including first and second choices and improvisations, for use in repairing engines. He discussed crankshaft testing equipment, bearing assemblies, hand-scraping and reaming of bearing bushings, machines for reboring, grinding and honing cylinders, piston-pin and ring fitting, and various other related matters.

H. W. Alden, past-president of the Society, and chairman of the board, Timken-Detroit Axle Co., in giving an exposition of methods of adjusting rear-axle gears and bearings, emphasized the importance of intimate contact between the engineer and the service-man. Too frequently they are widely apart in their work. Each can learn much from the other, and should do so for the benefit of the vehicle user. He said that the greatest service an engineer can expect from any part of his organization is that from a fair-minded intelligent service department. In addition, the right kind of engineer can be of the greatest assistance to the service manager. In Col. Alden's opinion poor repair work is due principally to lack of information. It is a good investment to furnish practical and adequate information to a service department, and such information is always welcome in that department. Showing moving-pictures, the speaker set forth the various stages of gear adjustment and taper roller-bearing adjustment.

Dr. F. C. Stanley, chief engineer of the Raybestos Co., talked on the mechanics of motor-car brake actuation. He said that the accumulation of dirt and rust is the chief cause of brake failure. With regard to testing brakes he advocated "the oldest and simplest method," namely, making them lock the wheels. We do not always need to apply brakes with sufficient force to lock the wheels, but should know that this ability is at our command. Doctor Stanley discussed at some length the following topics: Four-wheel brake adjustment, procedure in adjusting brakes, scoring of brake-drums, cause and remedy for squeaky brakes and types of brake.

The Relations of the Service-Man and the Engineer

Thos. J. Litle, Jr., chief engineer of the Lincoln Division, Ford Motor Co., gave his views as to how the service-man can cooperate with the engineer. In his opinion the problem of trying to give universal satisfaction to the user overshadows all other problems of the industry. The engineer is apt to be wrapped up in his particular work to such an extent that he does not appreciate the problems of the car user. Frequently his company brings out a new model every year, it being necessary consequently to retool the plant. After the engineer has completed his design and seen it carried properly into production, he should go out from his office, leaving the work there in charge of a competent assistant, and scrutinize carefully in the factory the manner in which his design is being produced. Moreover, he should go out into the field to visit the service-man.

Complaints from the field should be sent in triplicate to the factory for consideration there by the service, the manufacturing and the engineering departments.

Mr. Litle said that the service-man can be most effective in cooperating with the engineer by sending him definite information of troubles encountered in the field. He showed examples of good and of poor reports from service-men and also copies of forms used by various companies in methodical reporting of repairs made at service stations. Among these were some forms of report used by Durant Motors, Inc., for tabulating the number of repairs made in different parts of the Country on a given number of cars, the respective mileages of the cars being indicated. It is, of course, physically impossible for an engineer engaged with a large company to keep in direct touch with the details of engineering, manufacturing and service. In the Ford Motor Co. a technical service department has been established. This department, directly and through its field men, is in constant communication with the service managers of the company throughout the Country.

Heat-Treatment of Alloy-Steel Parts

L. A. Danse, chief metallurgist of the Cadillac Motor Car Co., presented a masterly address on the complex, fascinating and vitally important subject of the effect of heat-treating alloy-steel parts. He brought home in a telling way the points he wished to make in connection with car maintenance work. He showed lantern slides of steel-making processes, beginning with the mining of the ore. He explained in detail the necessity for securing good clean steel and for refining its crystalline structure properly. With bad inclusions in the material, heat-treatment is of no avail. He made clear, however, the fact that "clean steel" is a relative term; absolutely, there is no such thing.

Mr. Danse discussed, in addition to steel, iron and nonferrous alloys and their physical properties. He also outlined the fundamentals of welding operations.

Engine Lubrication

Having as a subject the effect of poor lubrication, Dr. W. K. Lewis, head of the department of chemical engineering, Massachusetts Institute of Technology, and chemical consultant, Standard Oil Co., discussed principles of lubrication with reference to automotive internal-combustion engine practice. Our present theories of lubrication are based on a knowledge of laws governing the motion of liquids, deduced by some of the ablest mathematicians of the modern world and substantiated by an overwhelming mass of experimental data. Oil adheres to the surfaces of both the shaft and the bearing and slippage occurs upon each of the successive oil-layers between the two surfaces. These individual films may be looked upon as a series of roller bearings, rolling upon one another. While the shaft tends to fall because of the downward thrust upon it, the rotation of the shaft forces oil up beneath it by a pumping action somewhat analagous to that of a rotary pump. Cylindrical bearings are characterized by the fact that the rotation of the shaft within the bearing tends to force the oil to the point where it is required for lubrication. In a cylinder, however, the piston-rings, scraping on the cylinder wall instead of dragging oil beneath the rubbing surfaces, tend rather to scrape from the wall of the cylinder any oil that may be there. Fortunately, the pressure of the piston-rings against the cylinder wall is very low, but nevertheless it is not easy to ensure an adequate amount of lubricant between the rubbing surfaces. The rings always operate under partial-film lubrication. The indications are that leakage of oil past well-fitting piston-rings is almost entirely behind the rings and not between them and the cylinder wall. Obviously, the more viscous the oil is, the less this leakage will be, because the resistance to the flow of oil through narrow passages between the rings and the grooves increases greatly as the viscosity of the oil goes up. The practical problem of automobile engine lubrication resides in the choice of that lubricant and the maintenance of those conditions of operation which will lubricate most satisfactorily both the bearings and the cylinder wall. If grit particles in a bearing are small compared to the minimum clearance between the shaft and the bearing, these particles will float through the bearing without scoring or abrasion.

Doctor Lewis said that it had been found in tests made at the Massachusetts Institute of Technology on two engines using the same oil, that the oil the dilution of which was greater contained a greater amount of iron. The experimental results point to the fact that crankcase-oil dilution, with resultant loss of "body" of the lubricant, increases abrasion in the engine.

Simple Accounting Records

W. G. Eiben, of the Comfort Printing Specialty Co., discussed the "high-lights" of simple accounting records. His theme was that every dealer's shop *can* and *should* make a profit.

The Electrical System

G. R. Fessenden, service engineer of the North East Electric Co., gave an elementary explanation of the electrical system. He said that the most prevalent causes of electrical troubles can be impressed upon the repairman, if it is pointed out to him that every unit is dependent to a very large extent upon the proper operation of every other unit therein. Moving-picture films were exhibited showing the principles of electricity and of the methods of operation of electrical units for ignition, lighting and starting purposes on automobiles.

MIDGLEY ADDRESSES MILWAUKEE SECTION

Some of the romance connected with the development of anti-knock chemical materials in the laboratories of the General Motors Research Corporation was presented in an entertaining address by Thomas Midgley, Jr. before the Milwaukee Section of the Society on May 28. H. L. Horning and others contributed to a lively discussion of fuel problems. The meeting was preceded by a dinner at the City Club.

NATIONAL MEETINGS CALENDAR

SUMMER MEETING
Spring Lake, N. J.—June 24-27

AUTOMOTIVE TRANSPORTATION MEETING
New York City—September

AERONAUTIC MEETING
Dayton—Oct. 2

PRODUCTION MEETING
Detroit—Oct. 22-24

SERVICE ENGINEERING MEETING
Cleveland—Nov. 18-19

MOTORBOAT MEETING
New York City—Jan. 7, 1925

ANNUAL DINNER
New York City—Jan. 8, 1925

ANNUAL MEETING
Detroit—Jan. 20-23, 1925

THE CARNIVAL
Detroit—Jan. 21, 1925

TENTATIVE STANDARDIZATION WORK

Criticism of all tentative reports should be sent to the Standards Committee in care of the Society

USE OF UNEDGED PLANKS NOT NEW

Chair Industry Has Followed Ford Motor Co. Practice for Many Years

Considerable publicity has been given recently to the system used by the Ford Motor Co. of cutting hardwood lumber for body parts direct from unedged planks as they come from the log, it being stated that this system shows savings of from 35 to 50 per cent over the usual practice of cutting lumber sawed to uniform size and grade. In cases where the log was curved or irregularly shaped, the scrap exceeded the usable lumber.

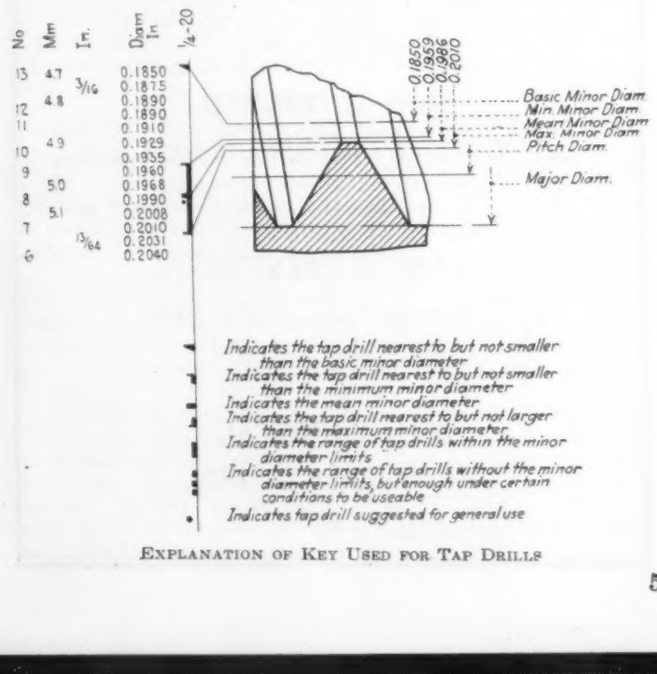
According to F. F. Murray, of the Hardwood Manufacturers' Institute, the practice of using unedged planks from the log has been followed for a number of years, particularly in Northern chair manufacturing plants, where the available timber is small and yet of sufficient value to warrant cutting.

The unedged board is, however, not a commercial commodity as yet inasmuch as it would be very difficult, if not impossible, to measure it in such terms as to preclude subsequent dispute, and likewise the grading of the unedged board would represent virtually an impossibility. In cases where log-run timber is bought it might be possible to feature "unedged" boards, but this would mean the acceptance of very low-grade material such as is rarely shipped today. Mr. Murray believes, however, that the Ford Motor Co. is practising a very high degree of utilization that might not be suitable for general application.

TAP-DRILL REFERENCE TABLES

List of Drills Indicates Those Suited for Different Minor-Diameter Limits

Believing that it is highly desirable to establish definite drill-sizes for the bore diameters specified in the report of the Sectional Committee on Screw-Threads, which was approved at the January meeting of the Standards Committee, the Screw-Threads Division has prepared tap-drill refer-


No
Mm
In.
Diam In
¼-20
0.1850
0.1939
0.1986
0.2010
Basic Minor Diam.
Min. Minor Diam.
Mean Minor Diam
Max. Minor Diam
Pitch Diam.
Major Diam.
Indicates the tap drill nearest to but not smaller than the basic minor diameter
Indicates the tap drill nearest to but not smaller than the minimum minor diameter
Indicates the mean minor diameter
Indicates the tap drill nearest to but not larger than the maximum minor diameter
Indicates the range of tap drills within the minor diameter limits
Indicates the range of tap drills without the minor diameter limits, but enough under certain conditions to be useable
Indicates tap drill suggested for general use

EXPLANATION OF KEY USED FOR TAP DRILLS

Number	Mm.	In.	Diameter In.	0-80	1-64	1-72	2-56	2-64
57			0.0430					
	1.10		0.0433					
	1.15		0.0453					
56			0.0465					
		3/64	0.0469					
	1.20		0.0472					
	1.25		0.0492					
	1.30		0.0512					
55			0.0520					
	1.35		0.0532					
54			0.0550					
	1.40		0.0551					
	1.45		0.0571					
	1.50		0.0590					
53			0.0595					
	1.55		0.0610					
		1/16	0.0625					
	1.60		0.0630					
52			0.0635					
	1.65		0.0650					
	1.70		0.0669					
51			0.0670					
	1.75		0.0689					
50			0.0700					
	1.80		0.0709					
	1.85		0.0728					
49			0.0730					
	1.90		0.0748					

Number	Mm.	In.	Diameter In.	3-48	3-56	4-40	4-48	5-40
48			0.0760					
	1.95		0.0768					
		5/64	0.0781					
47			0.0785					
	2.00		0.0787					
	2.05		0.0807					
46			0.0810					
45			0.0820					
	2.10		0.0826					
	2.15		0.0846					
44			0.0860					
	2.20		0.0866					
	2.25		0.0886					
43			0.0890					
	2.30		0.0905					
	2.35		0.0925					
42			0.0935					
		3/32	0.0937					
	2.40		0.0945					
41			0.0960					
	2.45		0.0965					
40			0.0980					
	2.50		0.0984					
39			0.0995					

TABLE 1—TAP-DRILL SIZES FOR SCREW-THREADS FROM NO. 0—80 TO NO. 5—40

Number	Mm	In	Diameter In	5-44	6-32	6-40	8-32	8-36
38			0.1015					
	2.60		0.1024					
37			0.1040					
	2.70		0.1063					
36			0.1065					
		7/64	0.1094					
35			0.1100					
	2.80		0.1102					
34			0.1110					
33			0.1130					
	2.90		0.1142					
32			0.1160					
	3.00		0.1181					
31			0.1200					
	3.10		0.1220					
		1/8	0.1250					
	3.20		0.1260					
30			0.1285					
	3.30		0.1299					
	3.40		0.1338					
29			0.1360					
	3.50		0.1378					
28			0.1405					
		9/64	0.1406					

Number	Mm.	In.	Diameter In	10-24	10-32	10-40	12-24	12-28	12-32
	3.6		0.1417						
27			0.1440						
	3.7		0.1457						
26			0.1470						
25			0.1495						
	3.8		0.1496						
24			0.1520						
	3.9		0.1535						
23			0.1540						
		5/32	0.1562						
22			0.1570						
	4.0		0.1575						
21			0.1590						
20			0.1610						
	4.1		0.1614						
	4.2		0.1653						
19	4.3		0.1660						
			0.1693						
18			0.1695						
		11/64	0.1719						
17			0.1730						
	4.4		0.1732						
16			0.1770						
	4.5		0.1772						
15			0.1800						
	4.6		0.1811						
14			0.1820						
13	4.7		0.1850						

TABLE 2—TAP-DRILL SIZES FOR SCREW-THREADS FROM NO. 5—44 TO NO. 12—32

Number	Mm	In	Diameter In	1/4 - 20	1/4 - 24	1/4 - 28	1/4 - 32	1/4 - 36	1/4 - 40	5/16 - 18	5/16 - 24	5/16 - 32	5/16 - 40
13	4.7		0.1850										
		3/16	0.1875										
	4.8		0.1890										
12			0.1890										
11			0.1910										
	4.9		0.1929										
10			0.1935										
9			0.1960										
	5.0		0.1968										
8			0.1990										
	5.1		0.2008										
7			0.2010										
		13/64	0.2031										
6			0.2040										
	5.2		0.2047										
5			0.2055										
	5.3		0.2087										
4			0.2090										
	5.4		0.2126										
3			0.2130										
	5.5		0.2165										
		7/32	0.2187										
	5.6		0.2205										
2			0.2210										
	5.7		0.2244										
1			0.2280										
	5.8		0.2283										
	5.9		0.2323										

Letter	Mm	In.	Diameter In.	5/16 - 18	5/16 - 24	5/16 - 32	5/16 - 40
A			0.2340				
		15/64	0.2344				
	6.0		0.2362				
B			0.2380				
	6.1		0.2401				
C			0.2420				
	6.2		0.2441				
D			0.2460				
	6.3		0.2480				
E		1/4	0.2500				
	6.4		0.2520				
	6.5		0.2559				
F			0.2570				
	6.6		0.2598				
G			0.2610				
	6.7		0.2638				
		17/64	0.2656				
H			0.2660				
	6.8		0.2677				
	6.9		0.2716				
I			0.2720				
	7.0		0.2756				
J			0.2770				
	7.1		0.2795				
K			0.2810				
		9/32	0.2812				
	7.2		0.2835				
	7.3		0.2874				
L			0.2900				

TABLE 3—TAP-DRILL SIZES FOR SCREW THREADS 1/4 IN.—20 TO 5/16 IN.—40

Letter	Mm	In	Diameter In	3/8 - 16	3/8 - 24	3/8 - 32
M	7.4		0.2913			
			0.2950			
	7.5		0.2953			
		19/64	0.2969			
N	7.6		0.2992			
			0.3020			
	7.7		0.3031			
	7.8		0.3071			
	7.9		0.3110			
		5/16	0.3125			
O	8.0		0.3149			
			0.3160			
	8.1		0.3189			
	8.2		0.3228			
P	8.3		0.3268			
			0.3230			
		21/64	0.3281			
	8.4		0.3307			
Q			0.3320			
	8.5		0.3346			
	8.6		0.3386			
R			0.3390			
	8.7		0.3425			
		11/32	0.3437			
	8.8		0.3464			
S			0.3480			
	8.9		0.3504			
	9.0		0.3543			
T			0.3580			7/16 - 14
	9.1		0.3583			

Letter	Mm.	In.	Diameter In	7/16 - 14	7/16 - 20	7/16 - 24	7/16 - 28	7/16 - 32	1/2 - 13	1/2 - 20	1/2 - 24	1/2 - 28
		23/64	0.3594									
	9.2		0.3622									
U	9.3		0.3661									
			0.3680									
	9.4		0.3701									
	9.5		0.3740									
		3/8	0.3750									
V			0.3770				0.3988*					
	9.6		0.3779									
	9.7		0.3819									
	9.8		0.3858									
W			0.3860				0.4027					
	9.9		0.3898									
		25/64	0.3906									
	10.0		0.3937									
X			0.3970									
Y			0.4040									
		13/32	0.4062									
Z			0.4130									
	10.5		0.4134									
		27/64	0.4219									
	11.0		0.4331									
		7/16	0.4375									
	11.5		0.4527								0.4549*	
		29/64	0.4531								0.4594	
		15/32	0.4687									0.4613*
											0.4652	

* Minor diameter limits; no drill available within these limits.

TABLE 4—TAP-DRILL SIZES FOR SCREW-THREADS FROM 3/8 IN.—16 TO 1/2 IN.—28

ence tables for the theoretical minor-diameter, the minimum minor-diameter and the maximum minor-diameter for all tapped holes specified in the S. A. E. Extra-Fine, the Fine and the Coarse Screw-Thread Series.

The purpose of these reference tables is to show drills suitable for use as tap drills for screw-thread depths of three-quarters and five-sixths of the theoretical thread-depth and for the full theoretical depth. They are not intended to indicate a specific tap drill, as the size of tap drill best suited to a given application is dependent upon the material, the nature of the cutting lubricant, the method of drilling and tapping and the condition of the cutting edges of the drill.

In cases where no drill is within the limits of the minor diameter of the tapped hole it is necessary to make a special sizing-tool, drill or reamer, or to allow the tap to size the minor diameter. The nearest available drill is indicated in the tables and the limits of the minor diameter are given.

Mm.	In.	Diameter In.	5/16 - 12	5/16 - 18	5/16 - 24	5/16 - 28	5/8 - 11	5/8 - 12	5/8 - 18	5/8 - 24
	15/32	0.4687								
12.0		0.4724								
	31/64	0.4844								
12.5		0.4921								
	1/2	0.5000								
13.0		0.5118								
	33/64	0.5156								
		0.5312								
13.5	17/32	0.5315								
	35/64	0.5469								
14.0		0.5512								
	9/16	0.5625								
14.5		0.5709								
	37/64	0.5781								
15.0		0.5905								
			0.5219	0.5174*	0.5238*					0.5844*
			0.5277							0.5799

* Minor diameter limits; no drill available within these limits.

Mm.	In.	Diameter In.	3/4 - 10	3/4 - 16	3/4 - 20	3/4 - 24	7/8 - 9	7/8 - 14	7/8 - 18	7/8 - 20	7/8 - 24
	19/32	0.5937									
	39/64	0.6094									
15.5		0.6102									
	5/8	0.6250									
16.0		0.6299									
	41/64	0.6406									
16.5		0.6496									
	21/32	0.6562									
17.0		0.6693									
	43/64	0.6719									
17.5	11/16	0.6875									
		0.6890									
18.0	45/64	0.7031									
		0.7086									
18.5	23/32	0.7187									
		0.7283									
	47/64	0.7344									
19.0		0.7480									
	3/4	0.7500									
	49/64	0.7656									
19.5		0.7677									
	25/32	0.7812									
20.0		0.7814									
	51/64	0.7969									
20.5		0.8071									
	13/16	0.8125									
21.0		0.8268									
	53/64	0.8281									
	27/32	0.8437									

TABLE 5—TAP-DRILL SIZES FOR SCREW-THREADS FROM 5/16 IN.—12 TO 7/8 IN.—24

Mm.	In.	Diameter In	1 - 8	1 - 14	1 - 20	1 - 24	1 1/8 - 7	1 1/8 - 12	1 1/8 - 16
	27/32	0.8437							
21.5		0.8464							
	55/64	0.8594							
22.0		0.8661							
	7/8	0.8750							
22.5		0.8858							
	57/64	0.8906							
23.0		0.9055							
	29/32	0.9062							
23.5	59/64	0.9219							
		0.9252							
	15/16	0.9375							
24.0		0.9449							
	61/64	0.9531							
24.5		0.9646							
	31/32	0.9687							
25.0		0.9842							
	63/64	0.9844							
1		1.0000							
25.5		1.0040							
	1 1/64	1.0156							
26.0		1.0236							
	1 1/32	1.0312							
26.5		1.0433							
	1 3/64	1.0469							
27.0	1 1/16	1.0625							
		1.0630							

Mm.	In.	Diameter In.	1 1/8 - 18	1 1/8 - 20	1 1/4 - 7	1 1/4 - 12	1 1/4 - 16	1 1/4 - 18	1 1/4 - 20
27.0	1 1/16	1.0625							
		1.0630							
27.5	1 5/64	1.0781							
		1.0827							
28.0	1 3/32	1.0937							
		1.1024							
28.5	1 7/64	1.1094							
		1.1220							
29.0	1 1/8	1.1250							
	1 9/64	1.1406							
		1.1417							
	1 5/32	1.1562							
29.5	1 11/64	1.1614							
		1.1719							
30.0	1 3/16	1.1811							
		1.1875							
30.5		1.2008							
	1 13/64	1.2031							
31.0	1 7/32	1.2187							
		1.2205							

TABLE 6—TAP-DRILL SIZES FOR SCREW-THREADS FROM 1 IN.—8 TO 1 1/4 IN.—20.

TABLE 7—PROPOSED STANDARD LIST OF TAP DRILLS

Diameter	Threads Per Inch	Drill Size			Diameter	Threads Per Inch	Drill Size	
		Number	Mm.	In.			Mm.	In.
0	80	....	1.20	....	1/2	13	10.5a	27/64
1	64	....	1.45	....	1/2	20	11.5b	7/16a
1	72	53	....	....	1/2	24	....	29/64
2	56	51	....	....	1/2	28	....	29/64
2	64	50	....	....				
					9/16	12	12.0	15/32
3	48	47	....	....	9/16	18	....	1/2
3	56	46	....	....	9/16	24	....	33/64a
4	40	44	2.20	....	9/16	28	....	33/64a
4	48	....	2.30	....				
5	40	39	....	....	5/8	11	....	17/32
5	44	....	2.60	....	5/8	12	13.5	....
					5/8	18	....	9/16a
6	32	....	2.70	....	5/8	24	....	37/64
6	40	34	....	....				
8	32	....	3.30	....	3/4	10	16.5	41/64a
8	36	29	....	....	3/4	16	....	11/16b, 43/64a
10	24	26	....	....	3/4	20	17.5	....
10	32	21	....	....	3/4	24	18.0	45/64a
10	40	....	4.20	....				
					7/8	9	....	49/64b, 3/4a
12	24	17	4.40	....	7/8	14	....	51/64
12	28	15	....	....	7/8	18	....	13/16
12	32	14	....	....	7/8	20	21.0b	13/16a
					7/8	24	....	53/64
1/4	20	8	....	....				
1/4	24	5	....	....	1	8	22.0	....
1/4	28	....	5.40	....	1	14	....	59/64
1/4	32	....	5.50	....	1	20	24.0	....
1/4	36	2	5.60	....	1	24	....	61/64
1/4	40	2	5.70	....				
					1 1/8	7	25.0	31/32a
5/16	18	....	6.40	....	1 1/8	12	26.5	1 1/32a
5/16	24	....	6.80	....	1 1/8	16	....	1 1/16b 1 3/64a
5/16	32	Ja	7.10	....	1 1/8	18	....	1 1/16
5/16	40	....	7.30a	....	1 1/8	20	27.0	....
3/8	16	....	7.90a	....	1 1/4	7	28.0	1 3/32a
3/8	24	....	8.40	21/64a	1 1/4	12	29.5	1 5/32a
3/8	32	....	8.70	....	1 1/4	16	30.0	1 3/16b
					1 1/4	18	....	1 3/16
7/16	14	....	9.20	23/64	1 1/4	20	30.5b	1 3/16a
7/16	20	....	9.80	....				
7/16	24	....	10.00	....				
7/16	28	V	....	....				
7/16	32	Y	....	....				

aPreferably for nuts, although slightly undersize.
bNot recommended for thread depths less than one diameter.

Under conditions where the drill can be depended upon to produce a hole somewhat larger than itself it may be safe to use a tap drill smaller than the minimum minor-diameter; on the other hand, if conditions are such that a tap drill may be depended upon to cut a hole its exact size or even slightly smaller, it may be safe to use a drill larger than the maximum minor-diameter, the extent depending upon how much the minor diameter is reduced in tapping.

The tables include tap drills for S. A. E. Coarse, Fine and Extra-Fine Screw-Threads as shown on p. C1 of the S. A. E. HANDBOOK. Other pitches heretofore in common use and likely to continue in use for some years to come are also listed. The bore after threading with the tap drill suggested for general use may not in some cases be within the prescribed minor-diameter limits; but screws in accordance with the S. A. E. specifications will assemble in them without minor-diameter interference.

SCREW-THREAD STANDARD ADOPTED

The S. A. E. Standard for Screw-Threads, p. C1 of the S. A. E. HANDBOOK, was largely abstracted by the Screw-Threads Division from the report of the Sectional Committee on the Standardization and Unification of Screw-Threads, which was organized, under the rules of procedure of the American Engineering Standards Committee by the American Society of Mechanical Engineers and the Society of Automotive Engineers. The report, which was prepared in collaboration with the National Screw Thread Commission, on which the American Society of Mechanical Engineers and the Society have been the two civilian participating organizations, was approved by the former society in December, 1923, and by the latter in February, 1924.

Following the Society's approval, the complete report of the Sectional Committee was forwarded to the American Engineering Standards Committee. The report met with unanimous approval and has consequently been recognized as an American Standard. The American Society of Mechanical Engineers has printed the complete report and copies are available in pamphlet form.

TABLE 8—DRILL SIZES FOR MINOR DIAMETERS OF THE COARSE-THREAD SERIES

Diameter	Threads Per Inch	Bore, Full Thread Depth[1]	Drill Size		Bore, 5/6 Thread Depth[2]	Drill Size		Bore, 3/4 Thread Depth[3]	Drill Size	
			Dec.	Nom.		Dec.	Nom.		Dec.	Nom.
1	64	0.05270	0.0532	1.35 mm.	0.05609	0.0551	1.40 mm.	0.05778	0.0571	1.45 mm.
2	56	0.06280	0.0630	1.60 mm.	0.06667	0.0669	1.70 mm.	0.06860	0.0689a	1.75 mma
3	48	0.07194	0.0728	1.85 mm.	0.07645	0.0768	1.95 mm.	0.07870	0.0785	No. 47
4	40	0.07952	0.0807	2.05 mm.	0.08494	0.0846	2.15 mm.	0.08764	0.0866	2.20 mm.
5	40	0.09252	0.0925	2.35 mm.	0.09794	0.0980	No. 40	0.10064	0.0995	No. 39
6	32	0.09741	0.0980	No. 40	0.10417	0.1040	No. 37	0.10755	0.1065	No. 36
8	32	0.12341	0.1250	1/8	0.13017	0.1299	3.30 mm.	0.13355	0.1338a	3.40 mma
10	24	0.13587	0.1360	No. 29	0.14489	0.1440	No. 27	0.14941	0.1495	No. 25
12	24	0.16187	0.1614	4.10 mm.	0.17089	0.1719	11/64	0.17541	0.1732	4.40 mm.
1/4	20	0.18505	0.1850	No. 13	0.19587	0.1960	No. 9	0.20129	0.2010	No. 7
5/16	18	0.24033	0.2402	6.1 mm.	0.25236	0.2520	6.4 mm.	0.25837	0.2570	F
3/8	16	0.29381	0.2950	M	0.30734	0.3071	7.8 mm.	0.31411	0.3125	5/16
7/16	14	0.34471	0.3464	8.8 mm.	0.36018	0.3594	23/64	0.36791	0.3680	U
1/2	13	0.40001	0.4040	Y	0.41673	0.4134a	10.5 mm.a	0.42506	0.4219	27/64
9/16	12	0.45425	0.4531	29/64	0.47229	0.4724	12.0 mm.	0.48131	0.4844	31/64
5/8	11	0.50691	0.5118	13.0 mm.	0.52659	0.5312	17/32	0.53653	.....	.....
3/4	10	0.62010	0.6350	5/8	0.64175	0.6406	41/64	0.65257	0.6496	16.5 mm.
7/8	9	0.73066	0.7344	47/64	0.75472	0.7500	3/4	0.76675	0.7656	49/64
1	8	0.83762	0.8437	27/32	0.86468	0.8661	22.0 mm.	0.87822	0.8750	7/8
1 1/8	7	0.93942	0.9375	15/16	0.97035	0.9687	31/32	0.98582	0.9844	63/64
1 1/4	7	1.06442	1.0625	1 1/16	1.09535	1.0937	1 3/32	1.11082	1.1093	1 7/64
1 3/8	6	1.15849	1.1562	1 5/32	1.19458	1.2031	1 13/64	1.21262	1.2187	1 7/32
1 1/2	6	1.28349	1.2812	1 9/32	1.31958	1.3190	33.5 mm.	1.33762	1.3386	34.0 mm.
1 3/4	5	1.49019	1.4961	38.0 mm.	1.53349	1.5312	1 17/32	1.55514	1.5551	39.5 mm.
2	4 1/2	1.71132	1.7126	43.5 mm.	1.75944	1.7656	1 49/64	1.78349	1.7812	1 25/32
2 1/4	4 1/2	1.96132	1.9687	1 31/32	2.00944	2.0079	51.0 mm.	2.03349	2.0312	2 1/32
2 1/2	4	2.17524	2.1719	2 11/64	2.22940	2.2244	56.5 mm.	2.25643	2.2500	2 1/4
2 3/4	4	2.42524	2.4219	2 27/64	2.47940	2.4803	63.0 mm.	2.50643	2.5000	2 1/2
3	4	2.67524	2.6772	68.0 mm.	2.72940	2.7344	2 47/64	2.75643	2.7559	70.0 mm.

[1]Theoretical thread-depth.
[2]Minimum minor-diameter.
[3]Maximum minor-diameter.
aThe nearest drill-size available is outside the minor-diameter limits by more than 1/2 of 1 per cent of the diameter.

TABLE 9—DRILL SIZES FOR MINOR DIAMETERS OF THE FINE-THREAD SERIES

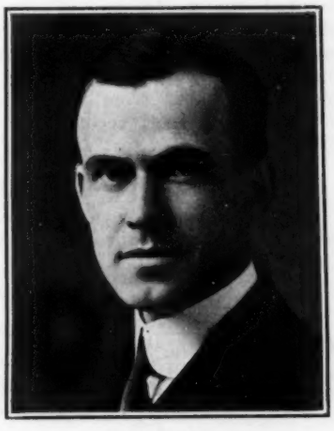
Diameter	Threads Per Inch	Bore, Full Thread Depth[1]	Drill Size		Bore, 5/6 Thread Depth[2]	Drill Size		Bore, ¾ Thread Depth[3]	Drill Size	
			Dec.	Nom.		Dec.	Nom.		Dec.	Nom.
0	80	0.04376	0.0453	1.15 mm.	0.04647	0.04650	No. 56	0.04782	0.0472	1.20 mm.
1	72	0.05496	0.0550	No. 54	0.05796	0.05710	1.45 mm.	0.05947	0.0595	No. 53
2	64	0.06570	0.0670	No. 51	0.06909	0.06890	1.75 mm.	0.07078	0.0709*b*	1.80mm.*b*
3	56	0.07580	0.0760	No. 48	0.07967	0.07850	No. 47	0.08160	0.0810	No. 46
4	48	0.08494	0.0846	2.15 mm.	0.08945	0.08900	No. 43	0.09170	0.0905	2.30 mm.
5	44	0.09548	0.0960	No. 41	0.10040	0.10150	No. 38	0.10286	0.1024	2.60 mm.
6	40	0.10552	0.1065	No. 36	0.11094	0.11100	No. 34	0.11364	0.1130	No. 33
8	36	0.12792	0.1285	No. 30	0.13393	0.13390	3.40 mm.	0.13694	0.1360	No. 29
10	32	0.14941	0.1495	No. 25	0.15617	0.15620	5/32	0.15955	0.1590	No. 21
12	28	0.16961	0.1695	No. 18	0.17734	0.17700	No. 16	0.18120	0.1811	4.60 mm.
12	32	0.17541	0.1770	No. 16	0.18217	0.18200	No. 14	0.18555	0.1850	No. 13
¼	28	0.20361	0.2040	No. 6	0.21134	0.21260	5.4 mm.	0.21520	0.2165*b*	5.5 mm.*b*
5/16	24	0.25837	0.2598	6.6 mm.	0.26739	0.26770	6.8 mm.	0.27191	0.2720	*I*
⅜	24	0.32087	0.3230	*P*	0.32989	0.32813*b*	21/64*b*	0.33441	0.3346	8.5 mm.
7/16	20	0.37255	0.3740	9.5 mm.	0.38337	0.38580	9.8 mm.	0.38880	0.3898	9.9 mm.
½	20	0.43505	0.4375	7/16.	0.44587	.....	.....	0.45129	0.4527	11.5 mm.
9/16	18	0.49033	0.4921	12.5 mm.	0.50236	0.50000	½	0.50837	0.5118	13.0 mm.
5/8	18	0.55283	0.5512	14.0 mm.	0.56486	0.56250	9/16	0.57087	0.5709	14.5 mm.
¾	16	0.66881	0.6693	17.0 mm.	0.68234	0.68750	11/16	0.68911	0.6890	17.5 mm.
⅞	14	0.78221	0.7812	25/32	0.79768	0.79688	51/64	0.80541	0.8071	20.5 mm.
⅞*a*	18	0.80283	0.8071	20.5 mm.	0.81486	0.81250	13/16	0.82087	0.8268*b*	21.0 mm.
1	14	0.90721	0.90620	29/32	0.92268	0.92188	59/64	0.93041	.....	.....
1⅛	12	1.01680	1.0156	1 1/64	1.03480	1.03130	1 1/32	1.04380	1.0433	26.5 mm.
1¼	12	1.14180	1.1406	1 9/64	1.15980	1.15630	1 5/32	1.16880	1.1719	1 11/64
1⅜*a*	12	1.26680	1.2656	1 17/64	1.28480	1.28130	1 9/32	1.29380	1.2969	1 19/64
1½	12	1.39180	1.3906	1 25/64	1.40980	1.40630	1 13/32	1.41880	1.4218	1 27/64
1 5/8*a*	12	1.51680	1.5156	1 33/64	1.53480	1.53130	1 17/32	1.54380	1.5468	1 35/64
1¾*a*	12	1.64180	1.6496	1 41/64	1.65980	1.65630	1 21/32	1.66880	1.6718	1 43/64
2*a*	12	1.89180	1.8906	1 57/64	1.90980	1.90630	1 29/32	1.91880	1.9218	1 59/64
2¼*a*	12	2.14180	2.1406	2 9/64	2.15980	2.15630	2 5/32	2.16880	2.1718	2 11/64
2½*a*	12	2.39180	2.8906	2 25/64	2.40980	2.40630	2 13/32	2.41880	2.4218	2 27/64
3*a*	10	2.87010	2.8750	2 7/8	2.89170	2.89060	2 57/64	2.90260	2.9063	2 29/32
6*a*	8	5.83760	5.8437	5 27/32	5.86470	5.85940	5 55/64	5.87820	5.8750	5 7/8

[1]Theoretical thread-depth.
[2]Minimum minor-diameter.
[3]Maximum minor-diameter.
*a*Not included in the S.A.E. Standard Screw-Thread Series.
*b*The nearest drill-size available is outside the minor-diameter limits by more than 1/2 of 1 per cent of the diameter

SECTIONAL COMMITTEE ORGANIZED

F. P. Gilligan Elected Chairman of Sectional Committee on Numbering of Steels

The organization meeting of the Sectional Committee on the Numbering of Steel was held on May 8 at the Navy Department Building in the City of Washington. F. P. Gilligan, chairman of the Iron and Steel Division of the Society's Standards Committee, was elected chairman of the Sectional Committee, A. G. Zimmerman, of the Naval Gun Factory, a representative on the Sectional Committee of the Federal Specifications Board, was elected vice-chairman, and L. A. Fry, representing the American Society for Testing Materials, was elected secretary.



F. P. GILLIGAN

The purpose of the Sectional Committee is to develop a National system of numbering steels based upon definite specifications. The Committee was appointed as a result of a general conference held in the City of Washington in 1922 under the auspices of the American Engineering Standards Committee. At this conference it was indicated that the American Society for Testing Materials and the Society should be the sponsors for such a committee, and they were consequently asked by the American Engineering Standards Committee to organize the committee.

At the organization meeting no action was taken specifically with reference to the numbering of steel. Another meeting will be held in the fall. Representatives of various steel manufacturers and users will be invited to attend. The subject before the Committee will be given further consideration, a general review of the numbering systems that have been developed, and are now in use in Europe, for ferrous and non-ferrous metals specifications, being contemplated.

This Sectional Committee was appointed early this year, the following associations being represented thereon:

American Boiler Manufacturers' Association
American Electric Railway Association
American Institute of Mining and Metallurgical Engineers
American Marine Standards Committee
American Railway Association
American Society of Mechanical Engineers
American Society for Steel Treating
American Society for Testing Materials
Association of American Steel Manufacturers
Bell Telephone System
Federal Specifications Board
Society of Automotive Engineers, Inc.

MACHINE-SCREW HEADS UNIFIED

A printed report covering the dimensions of flat-head, round-head and oval-head wood and machine screws; fillister-head machine-screws; and flat-head, button-head, oval fillister-head and flat fillister-head cap-screws, has been re-

(*Concluded on p.* 584)

AUTOMOTIVE RESEARCH

The Society's activities as well as research matters of general interest are presented in this section

FUEL RESEARCH PLANS DISCUSSED

Joint Committee Hears of Progress; Bureau of Standards Work Commended

At the May 16 meeting of the Joint Committee on Fuel Research in which the Society is cooperating with the American Petroleum Institute, the Bureau of Standards and the National Automobile Chamber of Commerce, great satisfaction in the Bureau's work was expressed by representatives of both the automotive and the petroleum industry. The feeling was unanimous that the Bureau has achieved results of far-reaching importance to the industries and to the general public. It was the sense of the Committee that the work should be continued with a view to maintaining a correct balance between the fuel and the engine.

Since the January meeting of the Committee, the study of crankcase-oil contamination has been continued, and in this work the Bureau has experimented with a new and very interesting method for measuring dilution. The engine tests conducted during the past 4 months have included runs with two different engines using various oils, some initially undiluted and others artificially diluted with gasoline or kerosene at the start. The effect upon dilution of changes in the jacket-water temperature has been given further attention, and the action of piston-rings as related to blow-by has been studied. Also, preliminary tests have been made in connection with the investigation of starting. Detailed results will probably be presented at the Summer Meeting of the Society.

The pleasure of the Committee as regards future work was expressed by a resolution unanimously adopted that recommended the continuation of the fuel research and included the following specific plans: first, that the factors contributing to crankcase-oil contamination be investigated; second, that the factors contributing to easy starting be investigated; and, third, that an investigation of vaporization be made to coordinate the design of internal-combustion engines and the volatility of fuels. Further, the resolution stated that the work aims to get the largest return from the crude, a more useful automotive product and the greatest service to the public.

In view of the fact that by far the greatest portion of the joint fuel research has been carried on at the Bureau of Standards, it was appropriate for the Committee to meet at that institution in the City of Washington. Opportunity was thus afforded for the members to inspect the laboratories and to come into closer contact with the actual work than would otherwise have been possible. The Committee was honored by the presence of Dr. G. K. Burgess, director of the Bureau, who welcomed them. Dr. T. G. Delbridge acted as chairman of the meeting.

NEW DIRECTOR OF HIGHWAY RESEARCH

Outlines Plans Before Executive Committee at Meeting on May 12

An outstanding point in connection with the new organization plan of the Advisory Board on Highway Research is the inclusion of a group of representatives to be appointed, one from each State, to serve as a medium for the interchange of information between the Advisory Board and the various State highway departments. It is not anticipated that all of the States in the Union will care to participate in the work at the present time, but the plan offers a means for bringing in such representatives as are interested. This organization plan was presented by Director C. M. Upham at a meeting of the Executive Committee of the Advisory Board on Highway Research which was held in the City of Washington at the Bureau of Public Roads on May 12. It was decided that the next meeting of the Committee should be held in the City of Washington on Tuesday, July 8, and that the chairmen of the various committees composing the Advisory Board should be invited to meet with the Executive Committee on that occasion for a general discussion of future plans and reports on the progress of the work.

Following the morning session the Committee lunched at the Cosmos Club, and after luncheon inspected with much interest the new building of the National Academy of Science and the National Research Council, where quarters have been provided for the Advisory Board.

BUREAU OF STANDARDS TELEMETER

Carbon-Pile Instrument Measures Displacements, Forces and Accelerations

A very interesting and practical engineering instrument known as the electrical telemeter has been developed recently at the Bureau of Standards.[1] It is well suited to a number of uses, including the measurement of small displacements, strains in structural members, forces and accelerations. Various possible applications of the instrument to specific engineering problems will be readily noted.

Those responsible for the design have apparently succeeded in eliminating the objectionable features that have limited the usefulness of similar instruments previously developed. An important advantage of this telemeter is its adaptability to remote indication and recording, the indicating or recording element being stationed conveniently in a position isolated from vibrations or other objectionable influences. Further, records may be obtained simultaneously from a number of test points.

Carbon Pile Resistance Elements Used

The instrument depends for its operation upon the changes of electrical resistance of stacks of flat annular rings of carbon, the resistance of which varies as the pressure upon

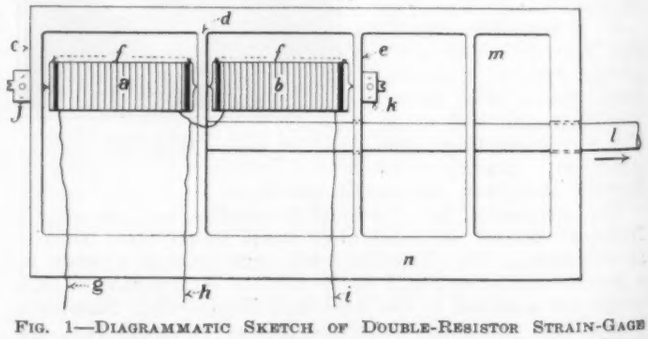


Fig. 1—Diagrammatic Sketch of Double-Resistor Strain-Gage
The Carbon Pile Resistors Are Shown at *a* and *b*. The Mounting *n* Serves as One Terminal of the Gage and the Rod *l* forms the Other Terminal

[1] See Bureau of Standards Technologic Paper No. 247, by Burton McCollum and O. S. Peters.

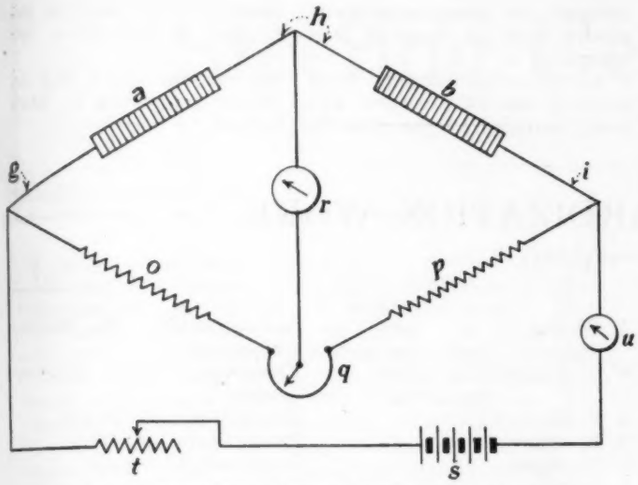


FIG. 2—WHEATSTONE BRIDGE INDICATING ELEMENT

Carbon Resistors *a* and *b* Are Shown Connected in Two Arms of the Bridge. The Instrument Is Changed to the Recording Type by Replacing the Milliammeter *r* by an Oscillograph

them changes and slight displacement occurs. By a Wheatstone bridge, indications of the resistance changes are obtained, and it becomes possible to evaluate the quantity in question.

The carbon rings after being ground to proper dimensions are assembled and mounted in a suitable frame. Two stacks, *a* and *b*, are shown in the double-resistor type of strain-gage of Fig. 1. In this diagrammatic sketch, the resistor *a* is held under pressure between the plates or diaphragms *c* and *d*, and the resistor *b* between the plates *d* and *e*. The two units are insulated from the frame by the bushings *f*, and the leads *g*, *h* and *i* extend to the indicating or recording elements. Set-screws *j* and *k* provide for adjusting the stacks to the proper initial pressure, the points of support being designed so as to insure axial loading. Rod *l* is attached at the center of the plate *d*, extends through the plate *e*, and thence to and beyond the plate *m* to which it is also firmly fixed. Thus, the rod *l* forms one terminal of the gage and the frame or mounting *n* the other. It should be mentioned that the frame is preferably machined in one piece, the absence of mechanical joints making possible the elimination of hysteresis effects.

WHEATSTONE BRIDGE INDICATING ELEMENT

As shown diagrammatically in Fig. 2, the resistors *a* and *b* may be connected through the leads *g*, *h* and *i* in two arms of a Wheatstone bridge, the other two arms of which contain fixed balancing resistances *o* and *p*, that may be adjusted by the slide-wire resistance *q*. Indications of balance are given by the milliammeter *r*. The total flow of current from the battery *s* is regulated by the variable resistance *t* and is indicated by the ammeter *u*.

OPERATION

Assuming that the bridge is balanced so that the indicating pointer of *r* rests at the proper initial position, a force applied in the direction of the arrow to the rod *l*, Fig. 1, will cause a decrease of pressure and a corresponding increase of resistance in the resistor *a*, and an increase of pressure with a decrease of resistance in the resistor *b*. These two effects are cumulative in so far as their influence toward unbalancing the bridge is concerned. The lack of balance, an indication of the magnitude of forces acting upon the gage, is shown by the milliammeter *r*, Fig. 2. When it is desired to make a record of the effects, the milliammeter *r* is replaced by an oscillograph.

The principal advantages of the double-resistor arrangement described above are two-fold. First, a given effect on the indicating instrument is obtained by using only one-half as much displacement of each resistor as would be necessary were only one unit employed; and, owing to the character of the non-linear relation between the pressure and the resistance of each unit, the departure from a straight-line calibration is less for the small displacement range. Second, by virtue of the superimposing of effects from the two resistors, the deflection of the instrument becomes substantially a linear function of the applied force.

Measurements of forces, stresses and displacements can be made under favorable conditions with errors not exceeding 2 per cent.

APPLICATIONS

In extensive tests of brake-lining at the Bureau of Standards, described in a paper[2] by S. von Ammon, entitled Developing a Method for Testing Brake-Linings, the telemeter has been found very useful. Fig. 3 illustrates the method of attaching the instrument *A* between the free ends of the pressure arms of the testing apparatus. Here it serves to measure the pressure with which the shoes are pressed against the drum. The reading of a spring-balance first used in this connection was tedious. This difficulty has been surmounted by the use of the telemeter.

This instrument has been used to measure the stress in flexible members, including the stay-cables of airplanes in

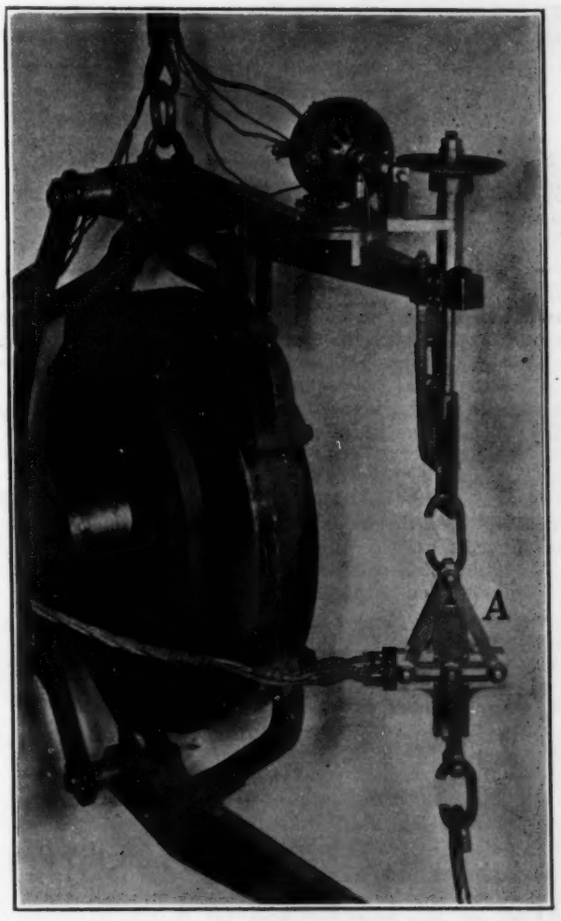


FIG. 3—TELEMETER APPLIED TO APPARATUS FOR TESTING BRAKE-LINING AT THE BUREAU OF STANDARDS

The Instrument *A* Is Mounted between the Free Ends of the Pressure Arms of the Testing Apparatus. The Indicating Element Is Not Shown

flight. Other applications include the testing of structural members for bridges and airships. In the latter connection, it is interesting to note that much information of value was obtained from telemeter measurements made on the

[2] See THE JOURNAL, March, 1922, p. 153.

Navy rigid airship, Shenandoah, during recent tests. Certain of the members were also tested by this method before being assembled.

The recording type of instrument is particularly well adapted to the measurement of vibratory and transient forces and displacements. In the measurement of vibratory stresses the pressure-resistance characteristics may be depended upon at rates at least as high as 840 cycles per second.

Air pressures ranging from 0 to 300 mm. (11.8 in.) of mercury and oil pressures up to 40,000 lb. per sq. in. have been measured by the telemeter method.

TENTATIVE STANDARDIZATION WORK

(*Concluded from p.* 581)

leased by Subcommittee No. 3 of the Sectional Committee on the Standardization of Bolt, Nut and Rivet Proportions and is being distributed for comment by the American Society of Mechanical Engineers. The Sectional Committee, sponsored by the American Society of Mechanical Engineers and the Society, has not approved this report, but will base its action thereon on the comments that shall be received. Copies of the report have been sent to those whose names are on several of the Standards Committee mailing lists, these including members associated with all of the more important passenger-car, motor-truck, engine and body manufacturers. Additional copies will be sent other Society members interested in commenting on the report.

The nomenclature of slotted-head products is also included in the report, the following types being proposed as standard:

Flat-Head
Round-Head
Oval Countersunk-Head
Oval Fillister-Head
Flat Fillister-Head

Special types, which are to be made only on order, are also listed in the nomenclature.

GAS HEAD-LAMP STANDARD NEEDED

At the meeting of the Lighting Division held in Detroit on April 28 the necessity for developing specifications for motor-truck gas head-lamps was emphasized, inasmuch as the builders of motor trucks have experienced trouble due to the fact that various States inspect and pass upon truck head-lamps on the basis of the head-lamp illumination specifications for motor-vehicle electric head-lamps developed by the Illuminating Engineering Society and the Society.

It was reported that the following specifications were first temporarily and later definitely adopted by the State of Massachusetts:

> Light from acetylene lamps is legal when the lamps are equipped with clear glass fronts, ⅝-ft. burners and 6-in. mirrors.

It was considered advisable to take prompt action on this matter and a subdivision was therefore appointed to study the situation and report back to the Division. The Subdivision appointed is as follows:

A. J. Scaife, *Chairman*	White Motor Co.
C. E. Banta	Adams & Westlake Co.
A. K. Brumbaugh	Autocar Co.
A. W. Devine	Commonwealth of Massachusetts
W. F. Little	Electrical Testing Laboratories
A. F. Masury	International Motor Co.
O. F. Ostby	Prest-O-Lite Co., Inc.
C. D. Ryder	Cincinnati Victor Co.

SHAFTING STANDARDS ADOPTED

Final Report on Diameters for Transmission and Machinery Shafting-Stock

The American Society of Mechanical Engineers has approved the report of the Sectional Committee for the Standardization of Shafting, proposing for adoption as American Standard the following diameters for cold-finished transmission and machinery shafting:

> Standard diameters for cold-finished transmission-shafting stock shall be 15/16, 1-3/16, 1-7/16, 1-11/16, 1-15/16, 2-3/16, 2-7/16, 2-15/16, 3-7/16, 3-15/16, 4-7/16, 4-15/16, 5-7/16, and 5-15/16 in.
>
> Standard diameters for cold-finished machinery-shafting stock shall be: Up to 2½ in., by sixteenths of an inch; from 2½ to 4 in. inclusive, by eighths of an inch; from 4 to 6 in., by quarters of an inch.
>
> Standard tolerances for diameters of cold-finished transmission and machinery-shafting stock shall be

Diameter, In. From	To	Tolerance, In.
0.000	1.000	— 0.002
1.000	2.000	— 0.003
2.000	4.000	— 0.004
4.000	6.000	— 0.005

> Standard stock lengths for cold-finished shafting shall be 16, 20 and 24 ft.

The Sectional Committee report has been transmitted to the American Engineering Standards Committee for approval as a Tentative American Standard. The members of the Subcommittee on Shaft Dimensions which developed this report are L. W. Williams, of Cauldwell-Wingate Co.; J. E. Bushnell and J. J. Shuman, of Jones & Laughlin Steel Co.; F. M. Waring, of the Pennsylvania Railroad; and C. M. Chapman.

SOUTH AMERICA

GREAT as has been her progress in the past century, South America, with her 7,000,000 sq. miles of territory and her population of 60,000,000 possesses vast capacity for development as a producer of the world's most needed commodities, and, with the settlement of the international problems and the restoration of the buying power of European markets, we shall doubtless witness great strides in prosperity in the continent. The safety of business enterprises depends, of course, to a considerable extent upon political stability, and I would venture to say that prejudice against most of the South American republics on this point is distinctly unjust, as in the more prosperous countries the prospect of political upheavals of a really serious nature is probably less than in many other civilized nations. The peoples comprised within the geographical term "South America" have always adopted a liberal policy toward the financial and commercial stranger within their gates, and there is every reason to hope that this broad-minded attitude will continue to influence the policy of the various republics.—R. J. Hose, Anglo-South American Bank.

Vol. XIV June, 1924 No. 6

Steering-Gear Analyses

By F. F. CHANDLER[1]

INDIANA SECTION PAPER *Illustrated with* CHARTS

LACK of scientific research is specified by the author as being the cause of failure to develop steering-systems generally to meet the present need for better and easier steering-ability. He comments upon the meager data available regarding steering-system faults and factors that influence design and emphasizes the necessity for determining the live stresses in steering-systems while the vehicle is traveling over roads of all kinds, so that designs can be made with greater confidence and greater safety attained. Defining comfort as being inclusive of easy steering, a comfortable sitting position, convenient location of the controls that must be handled frequently and peace of mind relative to steering accuracy and dependability, he analyzes the causes of hard steering, saying that the steering-system includes every part from the steering wheel through the steering-gear and linkage to the front wheels and that the steering-gear itself is simply the reduction mechanism.

Assisted by H. A. Huebotter, he is developing a set of automatic recording instruments that will record not only the physical effort needed to steer an automobile but, simultaneously, the forces and shocks imposed upon the entire steering-system, so that such records will constitute a basis for steering-system design.

It is essential that the steering-gear provide the necessary mechanical advantage or leverage that will enable the driver to handle the car, and that this be accomplished with a reasonable angular turning-movement of the steering-wheel. Unfortunately, these two fundamental requirements conflict, in that an increase of mechanical advantage causes a greater amount of steering-wheel turn; so, charts are presented to show that the final overall mechanical advantage is made up of factors such as helix ratio, inside ratio and the relationship of the diameter of the steering-wheel to the length of the steering-arm, and as aids to the analyses that follow, to the end that present steering-system faults may be minimized.

Steering-gears are classified as bevel-gear-and-segment, worm-and-wheel, screw-and-nut, split-nut and cam-and-lever types, and all but the first depend upon a helix for actuation. A study of helix characteristics follows, a description of the test apparatus being included, and the possibilities of producing a variable-ratio helix that gives great mechanical advantage in the center-driving position with smaller mechanical advantage in the extreme positions are discussed. The author says that a steering-gear must absorb all objectionable road shocks and still retain road sympathy; that is, it must be a gear that permits the front wheels to follow the road more or less naturally, so that somewhat of a self-steering effect is secured.

LACK of general development in steering-systems is due largely to the fact that the conventional layout used has operated with a reasonable degree of satisfaction. Engineers say: "Why change? Our cars steer satisfactorily." In the main, cars have been thought to steer satisfactorily because the driving public has not been conscious that easier steering is obtainable. Some builders have made a conscientious effort toward better steering and have succeeded, and some parts makers have been helpful in this, but I believe that no one has ever undertaken the necessary research work to accomplish basic improvement for the industry as a whole, although almost every engineer can tell, if he will, what he has done to make his own car better as regards steering-ability.

All automotive engineers should read carefully the paper by Herbert Chase entitled, A Critical Study of Modern Automotive-Vehicle Steering-Systems.[2] In it, Mr. Chase says:

> Steering-systems employed on many modern passenger-cars and trucks are known to have certain faults, but the literature of the automotive industry contains surprisingly little helpful information regarding either these faults or the factors that should control the design of the system as a whole. Neither the TRANSACTIONS of the Society nor the *Proceedings of the British Institution of Automobile Engineers* contain any papers dealing with the subject except by incidental or casual reference.
>
> Many of the facts given in my paper can be said to be virtually self-evident, yet it is surprising how frequently they are overlooked in actual practice.

Time need not be wasted by arguments that steering-systems must, above all things, be safe; but, so far as I know, no one has any knowledge at present of the live stresses in steering-systems while the car is in motion or has ever taken the trouble to find out what these stresses are. I have made a fairly careful search and can find no such data; but engineers will say, "steering-systems do not break." They do not break often, but they do break sometimes. Therefore I maintain that, if data were obtained of the steering-forces while cars actually are traveling over roads of all kinds, we could then design steering-systems with confidence and attain greater safety than we possibly can now.

STEERING COMFORT

In the design of automobiles from now on, very careful consideration must be given to comfort. That includes easy steering, a comfortable sitting position, convenient location of the controls that must be handled frequently and peace of mind relative to steering accuracy and dependability. Ease is a synonym for comfort and therefore we must have easy steering; but it is easier to make this statement than it is to accomplish the result. It will require a much greater amount of hard work to make steering easy than has ever been put into the subject in the past, because of many new factors that have to be taken into consideration. Just as it takes basic knowledge of the steering-forces to make steering safe, so it will take basic knowledge to increase the comfort of steering.

HARD STEERING

Writers on this subject have stated that hard steering can be attributed to friction, faulty design, bad lubrication, failure to exclude dirt and water, excessive bearing-pressure and under-inflation of tires. It is known also that fabric tires steer harder than solid tires, cord tires

[1] M.S.A.E.—Chief engineer, Ross Gear & Tool Co., Lafayette, Ind.

[2] See THE JOURNAL, April, 1923, p. 377.

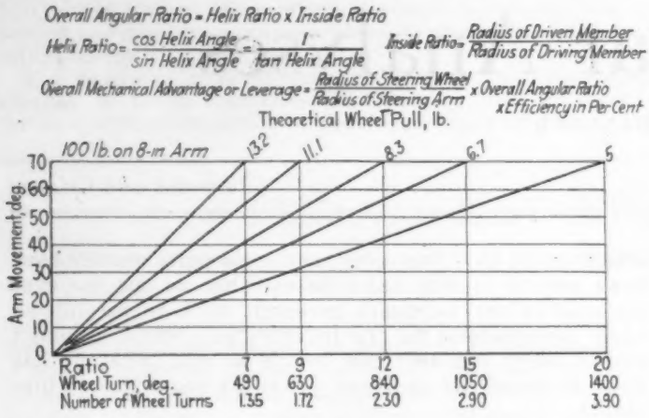

Overall Angular Ratio = Helix Ratio x Inside Ratio
Helix Ratio = cos Helix Angle / sin Helix Angle = 1 / tan Helix Angle
Inside Ratio = Radius of Driven Member / Radius of Driving Member
Overall Mechanical Advantage or Leverage = Radius of Steering Wheel / Radius of Steering Arm x Overall Angular Ratio x Efficiency in Per Cent
Theoretical Wheel Pull, lb.
100 lb. on 8-in Arm
13.2
11.1
8.3
6.7
5
Arm Movement, deg.
70
60
50
40
30
20
10
0
Ratio 7 9 12 15 20
Wheel Turn, deg. 490 630 840 1050 1400
Number of Wheel Turns 1.35 1.72 2.30 2.90 3.90

FIG. 1—OVERALL ANGULAR RATIO OF STEERING-GEARS

With a Ratio of 7 to 1, It Is Evident That 490 Deg. of Steering-Wheel Movement Is Required for an Assumed Steering-Arm Movement of 70 Deg.; That Is, the Wheel Must Be Turned 1.35 Times to Secure 70 Deg. of Movement of the Steering-Arm. As Larger Cars Were Produced, This Ratio Had To Be Increased, So at Various Points on the Chart, Steering-Gears Having Other Ratios Are Shown and Also the Number of Wheel-Turns Needed To Produce a 70-Deg. Movement of the Steering-Arm. Final Overall Mechanical Advantage or Leverage Is the Result of a Combination of a Number of Factors Such As Helix Ratio and Inside Ratio, As Well As the Relationship of the Diameter of the Steering-Wheel to the Length of the Steering-Arm. As Shown, It Is Always Desirable To Secure the Steering Movement with the Least Possible Number of Wheel-Turns

steer harder than fabric tires and balloon tires steer harder than cord tires. Inclined king-pins, the amount of weight on the front wheels, steering-moment, foregather or toe-in, wheel-wabble or shimmy, center-point steering, having all wheels turn about a common center and the like, are factors that affect steering. Some of these have both advocates and opponents. Most of these subjects have been treated, but the treatment mostly has been that of theoretical and mathematical analyses; while such treatment is good, it can give nothing but a meager idea of what the live forces are in a car that is moving over a road under its own power.

During all the years that these matters have been discussed, no one has trained himself particularly to delve into the mechanics of the steering-gear itself, which usually has to take the blame if steering goes wrong, or to develop new ideas that might actually and definitely improve the operation from the drivers' standpoint. We all forget that the steering-gear of a car is the one and only thing with which the driver must be in constant contact; his life depends upon it. We are losing a great psychological sales bet by our lack of engineering advancement toward the betterment of steering-systems. The steering-system, as I have discussed it, is the whole bag of tricks from the steering-wheel clear on down through the steering-gear, linkage and the like to the front wheels; the steering-gear is simply the reduction mechanism, nothing else. We spend countless hours trying to extract a few more ounces of torque from a gallon of gasoline to add a few more miles per hour to speed, and yet we say comparatively little about whether the car can be steered safely, accurately or easily after we get it going. The best steering cannot be secured by any steering-gear manufacturer alone, because the steering-gear is one part only of the whole system.

STEERING-SYSTEM RECORDING-INSTRUMENTS

With the help of H. A. Huebotter, research assistant at Purdue University, I am trying to design some automatic recording instruments that, if successful, will produce graphical records. They will record not only the physical effort necessary to drive automobiles but, simultaneously, the forces and shocks imposed upon the entire steering-system. This has had attention for many months; the job is not easy, but progress is being made. When the idea was first conceived, I thought it could be accomplished promptly and I had hoped by now to have a set of records from such instruments to use as a basis of steering-system design. The records will give actual data of the live forces that stress the members of the entire steering-system and, at the same time, a record of the manual effort necessary on the driver's part to accomplish the results.

THE STEERING-GEAR

A most important as well as a most neglected part of the steering-system is the steering-gear. Two fundamentals must be taken into consideration in any steering-gear design. They are (*a*) to secure the very necessary mechanical advantage that will give the driver the necessary leverage to handle the car and (*b*) to do this with a reasonable angular turning-movement of the steering-wheel. It is unfortunate that these two fundamental requirements are so incompatible. They are incompatible because, to secure great mechanical advantage or overall

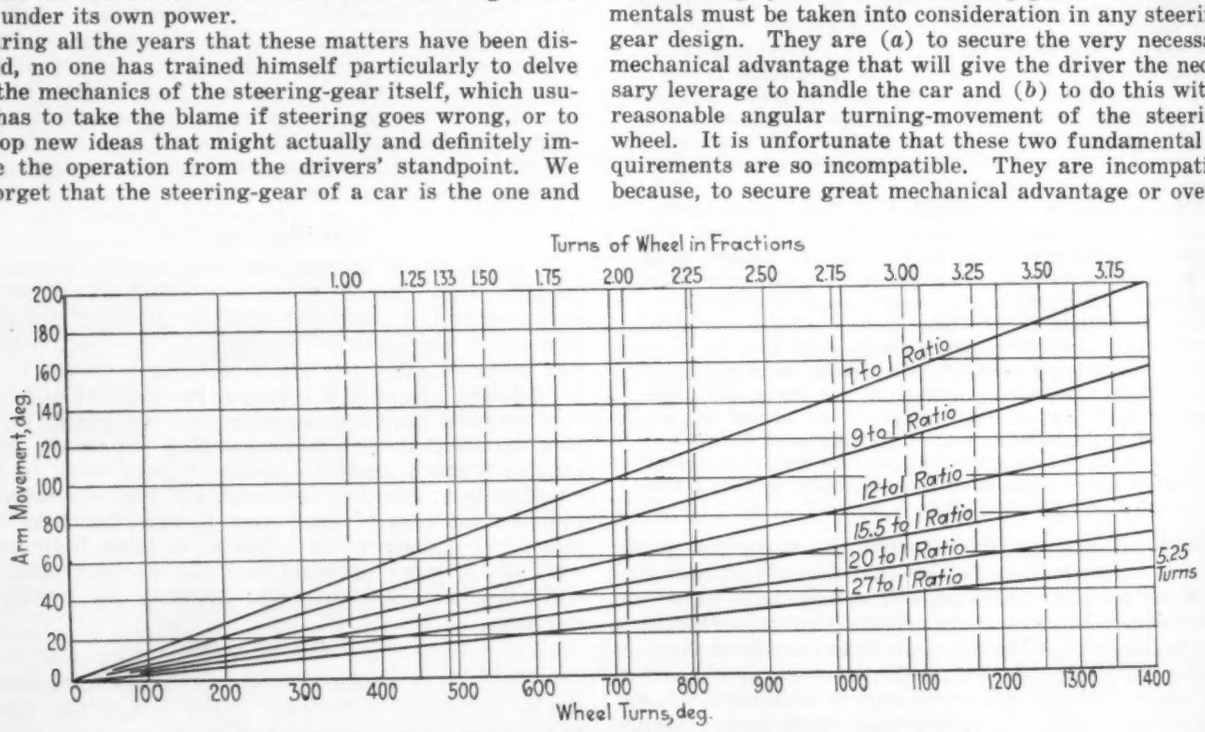


FIG. 2—WHEEL-TURNS NEEDED TO PRODUCE VARIOUS STEERING-ARM MOVEMENTS

Readings in Degrees of Wheel-Turn for Various Steering-Arm Movements in Steering-Gears of Conventional Overall Angular Ratios Varying from 7 to 1 to 27 to 1 Can Be Taken From This Chart

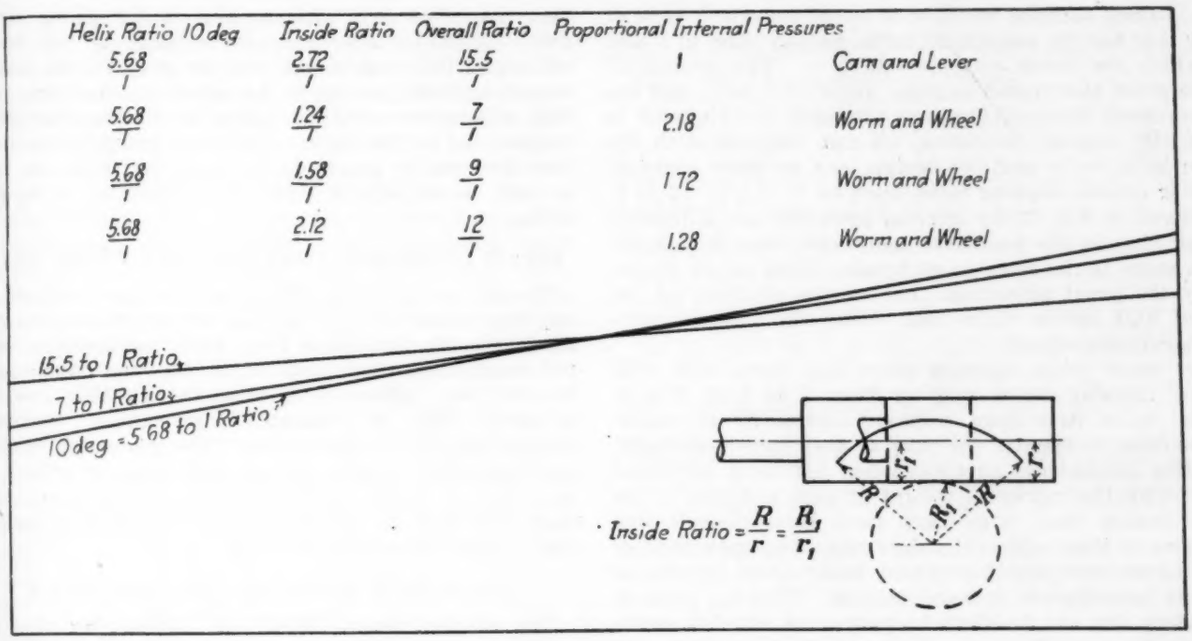

Helix Ratio 10 deg
Inside Ratio
Overall Ratio
Proportional Internal Pressures
5.68/1 2.72/1 15.5/1 1 Cam and Lever
5.68/1 1.24/1 7/1 2.18 Worm and Wheel
5.68/1 1.58/1 9/1 1.72 Worm and Wheel
5.68/1 2.12/1 12/1 1.28 Worm and Wheel
15.5 to 1 Ratio
7 to 1 Ratio
10 deg = 5.68 to 1 Ratio
Inside Ratio = R/r = R1/r1
R
r
R1
r1

FIG. 3—RELATION BETWEEN THE HELIX RATIO AND THE INSIDE RATIO

If a 10-Deg. Line Be Applied as Shown, This 10-Deg. Helix Would Have a Ratio of 5.68 to 1. If, However, this Helix Ratio Be Multiplied by the Inside Ratio, Say by 2.72 to 1 as Shown, the Product Becomes the Overall Angular Ratio of 15.5 to 1

angular ratio, it is necessary to get it at the expense of a reasonable angular movement of the steering-wheel.

Fig. 1 illustrates the overall angular ratio of steering-gears. As they were first manufactured, steering-gears usually had an overall angular ratio of 7 to 1. It will be seen from Fig. 1 that, with a ratio of 7 to 1, 490 deg. of steering-wheel movement is required for an assumed steering-arm movement of 70 deg.; that is, the wheel must be turned 1.35 times to secure 70 deg. of movement of the steering arm. As larger cars were produced, this ratio had to be increased; so, at various points on the chart, Fig. 1, steering-gears having 9 to 1, 12 to 1 and other ratios are shown as well as the number of wheel-turns necessary to secure a 70-deg. movement of the steering-arm. The 12 to 1 ratio is not uncommon at present. It is a comparatively new ratio, but even this ratio does not give a sufficient mechanical advantage to steer cars that are equipped with balloon tires, four-wheel brakes and the like and do it with ease. One passenger-car steering-gear on the market at present gives a 15 to 1 ratio.

From Fig. 1 it will be seen that the theoretical amount of wheel-pull for a 15 to 1 ratio is so light that it would not tax the strength of even a frail driver. In truck service, these angular ratios are greatly in excess of those used ordinarily; so, at one point, Fig. 1 shows a 20 to 1 ratio that would require 3.9 turns of the wheel to secure a 70-deg. movement of the steering-arm.

Owing to the construction of steering-gears the final overall mechanical advantage or leverage is, as shown in Fig. 1, the result of a combination of a number of factors such as helix ratio and inside ratio, as well as the relationship of the diameter of the steering-wheel to the length of the steering-arm. The steering-gear manufacturers are limited by the conventional designs of cars. The angular travel of the steering-arm varies from 65 to 85 deg. in cars of different makes. As seen from Fig. 1, it is always desirable to secure the steering-movement with the least possible number of wheel-turns; but, as the styles are rapidly including balloon tires and four-wheel brakes, cars equipped with these features have been forced to the use of steering-gears having a large overall angular ratio to secure the necessary overall mechanical advantage. Fig. 2 is a useful chart from which readings can be taken either in degrees of wheel-turn or fractions of wheel-turn for various steering-arm movements in steering-gears of conventional overall angular ratios varying from 7 to 1 to 27 to 1.

HELIX RATIO AND INSIDE RATIO

Many interesting results are due to the relation between the helix ratio and the inside ratio. Definitions are as follows:

> The overall angular ratio equals the helix ratio times the inside ratio.
>
> The helix ratio equals the cosine of the helix angle divided by the sine of the helix angle; or, it equals 1 divided by the tangent of the helix angle.
>
> The inside ratio equals the radius of the driven member divided by the radius of the driving member.
>
> The overall mechanical advantage, or leverage, equals the radius of the steering-wheel divided by the radius of the steering-arm, times the overall angular ratio, times the percentage of efficiency.

The analysis showing this relation between the helix ratio and the inside ratio is shown specifically in Fig. 3. For instance, if we applied a 10-deg. line as shown, this 10-deg. helix would have a ratio of 5.68 to 1. If, however, we multiply this helix ratio by the inside ratio, say 2.72 to 1 as shown, then the product becomes the overall angular ratio of 15.5 to 1. For a cam-and-lever type of gear, the inside ratio would be the ratio of the length of the inner driven arm R to the radius of the driving cam, r. In the case of worm-and-wheel gears, this inside ratio would be the ratio of the driven-wheel radius to the radius of the driving worm, or R_1 to r_1. These relations are shown also in diagrammatic form in Fig. 3. The inside ratio $= R/r = R_1/r_1$, in which $r = r_1$.

For comparison, suppose we say that the internal pressure produced between the working members described

is 1. Then suppose we have a worm-and-wheel type of gear that has the same helix ratio, namely, 5.68 to 1, and in which the inside ratio is 1.24 to 1. The product of these gives the overall angular ratio of 7 to 1, but the proportional internal pressure produced in this gear is 2.18. By similar reasoning, we can continue with the same helix ratio and, by design, can produce gears of greater overall angular ratio, such as 9 to 1 or 12 to 1. As shown in Fig. 3, the internal pressures are still much higher than in the gear first mentioned, even though the helix angle is the same in each case. This shows graphically the great advantage that can be attained by the use of high inside ratios that reduce the internal pressures correspondingly.

For many years, steering-gears have been built with overall angular ratios ranging from 7 to 1 to 9 to 1. These ratios have been sufficient ordinarily to enable the drivers to operate the cars as they have been built, but this mechanical advantage has not been increased much with the increased weight of cars and this is the basic reason that large cars have been difficult and tiresome to steer. Recently, however, the appearance of the balloon tire and four-wheel brakes has introduced further impediments to easy steering. This has made it necessary for car builders to give more careful attention to the overall angular ratios of steering-gears; so, recently, this ratio has been increased to 12 to 1. But even this ratio is not more than sufficient, in many cases, to take care of the total steering forces.

Inertia Forces and Friction

In addition to the greatly increased inertia forces in large cars operating at high speeds, as well as the very much greater frictional resistance to steering, a time element also enters. A heavy car traveling at 60 m.p.h. or 88 ft. per sec. theoretically should have a steering-gear that will permit the driver to cause the car to dodge obstacles more quickly than can a lighter car traveling at 25 m.p.h. or 36.66 ft. per sec. Unfortunately, however, if a steering-gear of great mechanical advantage is used to enable the driver to handle the car easily, this same gear takes from him the ability to cause the car to dodge quickly because he must move his steering-wheel so much farther in proportion to produce the necessary angular movement of the front wheels.

Successful efforts have been made to lessen the overall friction of the steering-system so that steering would be made easier. This has been accomplished by the use of anti-friction thrust-bearings in the front axles, by center-point-steering design, by using ball joints throughout to prevent binding effects and by spending large amounts of money to produce more efficient steering-gears. This reduction of friction has also been accomplished to a degree so that steering-gears of lesser mechanical advantage can be used on fast, heavy cars. Reasonably fast action that is so necessary in fast driving can be produced in this way but, along with the easier steering produced in the way described comes road shock, another very great objection. We have kept our fast-acting steering-gears that have been necessary at high speeds but we have increased overall efficiency so greatly that we get road shocks and wheel whipping that simply wear us out on long drives. Some of the best cars on the market today steer very easily; but, when touring on the roads that we find so frequently and that I fear will remain with us for some time, sore arms and muscles result from the incessant road shock forced into one's system by this greater efficiency of this easier steering-system. Gear wear is theoretically very much less on a steering-gear that has this reversibility to road shock because the parts do not have to withstand the road shocks and the gear should stand-up longer without having to be adjusted; but the shocks that otherwise would be taken by the mechanism are transmitted to the driver. However, practice has proved that irreversible gears can be made in which the initial as well as subsequent wear is so small as to be negligible.

Effect of Balloon Tires and Four-Wheel Brakes

To add to these difficulties, we now have balloon tires and four-wheel brakes. Balloon-tire representatives now admit frankly that these tires steer harder than standard tires, since they have found that the public probably will buy balloon tires even though they are hard to steer. Fig. 4 illustrates why balloon tires steer harder than do standard tires. The representatives say that four-wheel brakes add no hard-steering effects, and they do not in the models of cars so equipped, but I claim that they do add to steering difficulties in practice and I believe time will prove it.

Mechanical Advantage and Road Shock

The plotted results show how interesting this subject of steering really is. Again referring to the plotting of mechanical advantage, Fig. 1, which is the first requisite, all will say, of course, that the 5-lb. effort of the steering-arm is desirable because it will make steering easy; but they will be very emphatic in denouncing the 3.9 turns of the wheel needed to produce the desired steering effects and probably would object if forced by a car builder to move a steering-wheel more than 2.5 turns. While the great reductions are not desirable from the winding-up standpoint, yet they are desirable because they do tend to prevent road shock.

A steering-gear is a very interesting problem because so many factors are involved, any one of which may be good from one standpoint but may be bad from another. Regarding "efficiency," a most overworked word, most people would say that a steering-wheel is efficient if it turns easily, but this is not necessarily true; in fact, it is often a false premise. If a car steers easily, probably it is due more to a great mechanical advantage than to high efficiency, although high overall efficiency will, with a given reduction ratio, produce easier steering. The trouble is that road shock is increased when the efficiency is raised, unless the gear is made irreversible. Only two ways are possible to secure the elimination of road shock and wheel whipping. One is to use a reversible gear and enough other friction all along the line to damp out these shocks. The other way is to use an irreversible gear and eliminate as much friction all along the line as is possible. These are two extremes.

If we start out to eliminate the objectionable road shock, very much easier operation will be secured with an irreversible gear coupled with an efficient steering-system than with a reversible gear coupled with an inefficient steering-system. In the first instance we use an irreversible gear that theoretically is not efficient but that requires a small wheel-pull, coupled with an efficient system. In the second instance we use a reversible gear that requires a greater wheel-pull and theoretically is efficient, with an inefficient system. The effect on the driver is easier in the first case, but it always has been secured at the expense of a greater winding-up of the steering-wheel. However, it is very desirable to have, under some circumstances, a system

that is reversible; because such a steering-system permits a car to straighten-up automatically and, in this way, it contributes to easy handling. So far as the steering-gear itself is concerned, so many factors must be considered in the production of good steering that it is most confusing even to try to produce it.

Classes of Steering-Gear

First, we have the bevel-gear-and-segment type. It affords an easy way to obtain great mechanical advantage and is a gear of great relative efficiency; therefore, it probably transmits road shocks more than any other type. It must occupy much valuable space to secure the desired mechanical advantage. It is a gear of constant ratio, and it is easy to secure the desired angular movement of the steering-arm.

Second, we have the worm-and-wheel type. This also

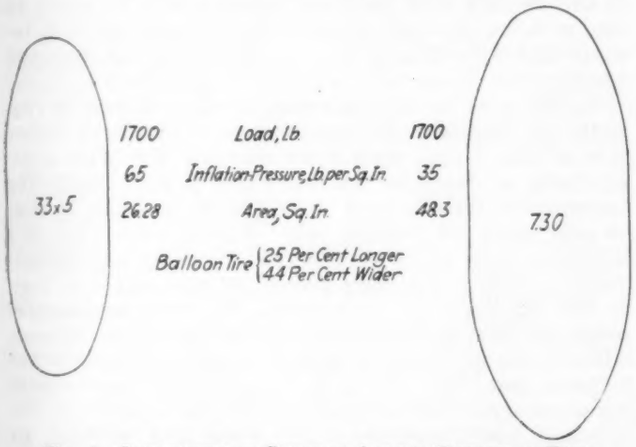


Fig. 4—Comparison of Steering-Ability Effects of Tires
Why Balloon Tires Are More Difficult To Steer Than Standard Tires Is Clearly Brought Out in This Diagram

is an easy way to secure the necessary mechanical advantage. Whether this type is efficient or not depends largely upon the helix angle of the worm. It must also be made large to secure the necessary mechanical advantage now required. This type is sometimes made as a worm and sector to reduce the amount of space occupied. It is a gear of constant ratio, and it is easy to secure the necessary angular movement of the steering-arm.

Third, we have the screw-and-nut type. This is made in many forms. It is easy to make it so that it has great mechanical advantage, and the efficiency is dependent largely on the helix angle of the screw used. It can be made to occupy a small space and is a gear of variable ratio. In some types the ratio decreases in the right or the left-hand extremes; in other types, the ratio increases. However, these variations are so slight that the ratio practically is constant. As usually made, it is low in efficiency. The design limits the possibility of securing large angular movement of the steering-arm.

Fourth, we have the split-nut type. The many characteristics are precisely the same as with the screw-and-nut type. It is also a variable-ratio gear, usually low in efficiency, and the design limits the possibility of securing large angular travel of the steering-arm.

Fifth, we have the cam-and-lever type. With this type, as usually produced, it is also easy to secure great mechanical advantage. It is a gear of variable ratio that easily can be produced to give any desired ratio and also can be made a constant ratio. Tests show that

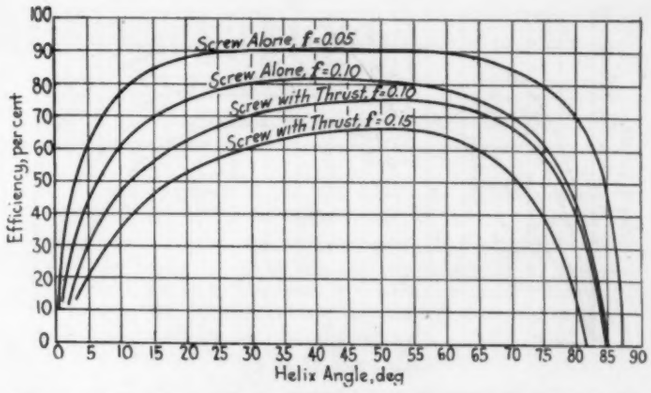


Fig. 5—Helix Efficiencies Plotted from Data Developed by Kimball and Barr
The Chart Shows That It Is Inherently Impossible To Secure Great Mechanical Advantage without Great Angular Reduction; or, without an Unreasonable Number of Turns of the Steering-Wheel. It Is Evident That a Helix Angle of Say 20 Deg. Is Very Much More Efficient Than a Helix Angle of Say 10 Deg.

the efficiency is usually high. It can be made irreversible in center driving and reversible in the extremes. The angular travel of the steering-arm can be made to conform to ordinary requirements.

Helix Characteristics

The worm-and-wheel, the screw-and-nut, the split-nut and the cam-and-lever types are all dependent upon the helix for actuation; therefore, a consideration of the helix characteristics becomes interesting. The input work is delivered by a helix or thread; the output is taken, respectively, from a driven wheel or sector, from a nut, sometimes split, from a rocker lever on a shaft or from a lever on a shaft, for the types stated. The efficiency of all these, which is the relation of output to input, is dependent very largely upon the efficiency characteristics of the helix itself. The other feature of having a long inner arm has already been stressed. Therefore, I have plotted graphs for helix efficiencies taken from data developed by Kimball and Barr, as shown in Fig. 5.

Fig. 5 shows that it is inherently impossible to secure great mechanical advantage without great angular reduction or, in other words, without an unreasonable number of turns of the steering-wheel. If a great mechanical advantage is secured in straight-away driving-positions or in driving positions that provide a reasonable variation on either side of the straight-away, then

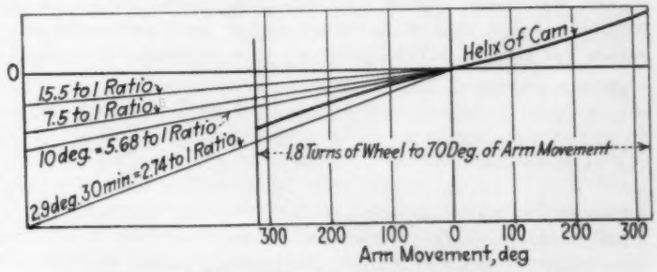

Helix of Cam
15.5 to 1 Ratio
7.5 to 1 Ratio
10 deg. = 5.68 to 1 Ratio
2 9 deg. 30 min. = 2.74 to 1 Ratio
1.8 Turns of Wheel to 70 Deg. of Arm Movement
Arm Movement, deg

Fig. 6—Development of a Variable-Ratio Helix
The Idea Is To Produce a Large Reduction or Great Mechanical Advantage in the Center Driving-Position, and Smaller Reductions or Smaller Mechanical Advantages in the Extreme Positions. If from Either Side of a 4-Deg. Portion of a 10-Deg. Helix-Angle for Center Driving-Position the Helix Angle Be Increased Gradually as Shown until the Extremes of Travel Would Make the Helix Angle 29 Deg. 30 Min., the Angular Ratio Changes from 15.5 to 1 in Mid-Position To Become 7.5 to 1 in the Extreme Positions. But the Efficiency Increases with This 29 Deg. 30 Min. Angle So That, as the Extreme Positions Are Approached, the Steering-Gear Becomes One That Positively Will Be Reversible. This Reversibility in the Extreme Position Is Desired Because All Drivers Like To Know That Their Cars Will Straighten-Up after Rounding a Turn

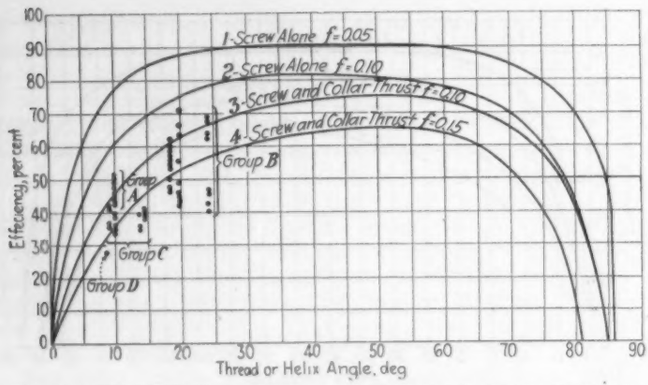


FIG. 7—CHART SHOWING THE RESULTS OF ACTUAL TESTS FOR DETERMINING HELIX EFFICIENCY-CHARACTERISTICS

This Chart Is Similar to Fig. 5 Except That Additional Efficiencies Are Plotted for Steering-Gears of Several Types. Curves 1 and 2 Are for a Screw Alone in Which the Coefficient of Friction Equals 0.05 and 0.10 Respectively. Curves 3 and 4 Are for a Screw and Collar Thrust in Which f Equals 0.10 and 0.15 Respectively. All Tests Were Made with a 50-Lb. Load on an 8-In. Steering-Arm. Points in Group *A* Are for the Cam and Lever Type in the Center-Driving Position. Group *B* Shows Points for the Cam-and-Lever Type in Extreme Positions. Group *C* Points Are for Worm-and-Wheel Gears Having Ratios Varying between 7 to 1 and 9 to 1, with Varied Helix Angles. The Point Shown as Group *D* Represents the Average Efficiency of a Split-Nut Type of Gear

the objectionable road shock is eliminated and very easy driving results. In right-hand or left-hand extremes of the turning movement, it is not so necessary to have a great mechanical advantage because the steering-gear is not often operated through these extremes.

It will be seen from the efficiencies shown in Fig. 5 that a helix angle of say 20 deg. is very much more efficient in action than a helix angle of say 10 deg. Therefore, if a steering-gear can be produced that has a helix angle of say 10 deg. in mid-position, with a comparative low resulting efficiency, and also with helix angles of say 20 deg. in either right-hand or left-hand extremes, a helix angle that is of very much greater efficiency, then two things are accomplished. First, the total amount of wheel movement necessary to throw the car from one extreme to the other is less than if the ratio of movement were constant and, in both the right-hand and the left-hand extremes, where a 20 deg. helix-angle is used, the extremes manifestly produce a greater amount of necessary wheel-pull; yet, because of the greater efficiency secured in these extremes, the extra amount of wheel-pull will not be so great as expected.

VARIABLE HELIX RATIO

Let us study for a moment the development of a variable ratio that will secure these very desirable results. A simple development of this variable-ratio idea,

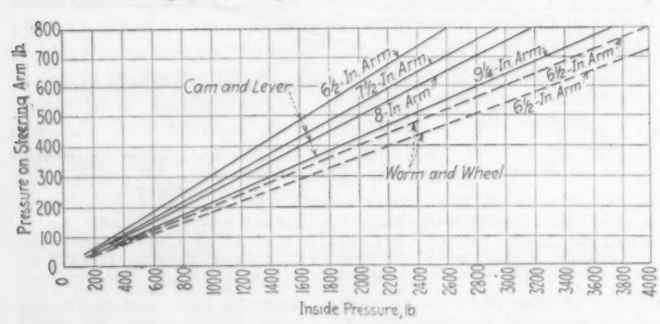


FIG. 8—INSIDE PRESSURES DUE TO VARYING STEERING-ARM LENGTH

For Steering-Gears of the Cam-and-Lever and the Worm-and-Wheel Type, the Chart Shows the Advantage of Using High Inside Ratios. Since Friction Loss Is Somewhat Dependent on the Inside Ratio, It Shows Also One Reason That Gears with High Inside Ratios Are More Efficient and Steer More Easily

producing a large reduction or great mechanical advantage in the center driving-position with smaller reductions or smaller mechanical advantages in the extreme positions, is shown in Fig. 6. Many steering-gears operating with a worm or screw have a helix angle of approximately 10 deg. With fine workmanship, the helix efficiency of this angle can be made to exceed 50 per cent. Under such circumstances, a steering-gear would be reversible theoretically. If the workmanship be not so good, the coefficient of friction therefore becomes greater and the helix angle will not produce an efficiency of 50 per cent; consequently, it becomes irreversible. Hence, for all practical intents and purposes, the helix angle of 10 deg. is the critical angle; whether it becomes reversible or not depends upon workmanship and lubrication. Therefore, if we wish to produce an irreversible steering-gear in straight-away driving-positions, it will be safe with ordinary workmanship to select 10 deg. as being the angle of the screw in center driving, because then we will be safe in assuming that the gear will become irreversible and will absorb road shocks.

In Fig. 6 if we take a 4-deg. portion of this 10-deg. angle, it therefore becomes sufficient. If from either side of this 4-deg. portion we increase the helix angle gradually as shown by the heavy line in Fig. 6 until the extremes of travel would make the helix angle 29 deg. 30 min., then the angular ratio changes from 15.5 to 1 in mid-position to 7.5 to 1 in the extremes; but the efficiency increases with this 29-deg. 30 min. angle so that, as the extremes are approached, the steering-gear becomes one that positively will be reversible. The reversibility in the extremes is desired because all drivers like to know that their cars will straighten-up when rounding a corner. This increase of the helix angle in the extremes also shortens-up the wheel-turn so that all these desirable features can be secured by these slight changes in the helix angle. It is indeed remarkable that such slight changes produce such large results. The heavy line is not very far from being a straight line. The helix shown is symbolical, and does not represent ratios that would be desirable in all cars necessarily. Any desired ratio can be produced in this type of gear.

Fig. 7 shows a plotting of some actual tests that were made; it is a duplicate of Fig. 5 except that additional efficiencies have been plotted for steering-gears of several types. The symbols used in plotting show these types. The efficiencies shown in Fig. 7 do not by any means cover all steering-gears, but other tests will be made from time to time that I am sure will go even farther toward proving the contentions of this paper. The tests completed show conclusively that gears having a large inside ratio are more efficient than those that have not. The plottings also prove the contention that efficiencies are higher when the helix angle is increased.

TEST APPARATUS

The test machine comprises a device for clamping a complete steering-gear with two drums, each of 2-ft. diameter; one drum is substituted for the usual steering-wheel and the other is substituted for the usual steering-arm. In conjunction with this, certain graduated dials were used to secure the overall angular ratio between the movement of the steering-wheel and that of the steering-arm. By applying certain definite loads on the drum substituted for the steering-arm, which loads were equal to certain equivalent pressures on the steering-ball of the steering-arm, it was therefore easy to determine

(*Concluded on p.* 648)

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Motorbus Transportation

By A. E. Hutt[1]

Pennsylvania Section Paper

THE underlying principles of motorbus transportation are outlined and suggestions are made concerning certain features that are conducive to successful operation. Among the points that should have careful consideration are said to be correct design and construction, efficient maintenance, intelligent operation, courteous employes and protective franchises. Special attention should be given to the design of parts, such as clutches, brakes, body details, including seats, and the protection of passengers against wind, rain and sun. Modern motorbuses are arranged for use with the P-A-Y-E system and when operated by one man a front-door exit is important.

Statements regarding the cost of maintenance are misleading because this depends upon the locality and the type of equipment. A low cost of fuel may be offset by a high cost of platform-men because of a lower speed of the motorbus. The total cost of operation is the important factor, not the reduction of any one item at the expense of another.

Maintenance also comprises both general overhaul every 2000 miles and annual overhaul. In the former, attention is devoted principally to lubrication, the tightening of loose parts and cleaning, but in the latter the whole vehicle is disassembled and thoroughly rebuilt. After coming from the shop the vehicle is considered as good as or better than new. Although the general practice is to depend on the annual overhaul, the system followed in Philadelphia is based on unit overhaul. This is considered preferable because of the difference in the life of different parts. Parts are inspected and overhauled after 2000-mile periods, whereas the annual overhaul occurs after a mileage of from 40,000 to 75,000.

Schedules are governed by the volume of traffic and the speed between terminals, but because of the flexibility of the service ordinary variations can be smoothed out and obstructions to traffic, such as those due to fires, can be overcome.

Having secured the right equipment and proper maintenance, the next step is to select operators of the proper class, for service should be based on courtesy. As the employes are the persons who come into direct contact with the public their conduct has a great effect in producing good feeling or in alienating the good will of the passengers.

I WISH to preface this paper with the statement that the views and the opinions expressed in it are my own and are not to be interpreted as necessarily representing the official views of the company by which I am employed.

Successful motorbus transportation requires

(1) Correctly designed and well-built vehicles

(2) An efficient system of maintenance, well carried out by properly trained mechanics

(3) An intelligent transportation force that appreciates all the natural advantages of this agent of transportation; particularly does this apply to the starters and the inspectors, who are the superintendent of transportation's first lieutenants in the field

(4) A force of drivers and conductors who are good soldiers; who are therefore amenable to discipline and who know or are willing to learn that courtesy is the one sure and solid foundation on which to build a public-utility business

(5) A franchise or operating license that will protect the company from destructive competition; that will place no oppressive or discriminatory taxation on its operation so that it can make a fair return on its investment. Any public-utility corporation must be prosperous if it is to give good service

Proper Equipment the First Requisite

The first requirement is, therefore, correctly designed and well-built equipment. When I say correctly designed, I mean from both an engineering and an operating standpoint. The successful designer must be very familiar with the nature of the service that the vehicle will be called upon to give, and will be governed accordingly. For instance, a certain type of clutch might be very satisfactory in long-haul interurban service, yet fail utterly in double-deck city operation where clutch applications run as high as 3000 or more per day. The same thing applies to the other cardinal units and especially to the brakes. Special attention should be given to the latter as larger buses are building every year, 67-passenger buses now as against 34-passenger buses 14 years ago, and the end is not yet in sight. Jules Verne in his fanciful stories depicted the airplane, the automobile and the submarine. The man in Detroit who visualizes a super-bus carrying 150 passengers may err only in that his vision may be cramped.

Special attention should be given to body-design, to supply the operator with a vehicle that will as nearly as possible fulfil all his transportation needs. The ideal double-deck motorbus should be built as low as possible; it looks better and safer. This supplies the psychological need of the passengers. It is safer because of the low center of gravity. It allows operation over routes that would be prohibitive for a higher vehicle on account of bridges, viaducts and the like, and therefore its field of operation will be wider and its usefulness increased.

The upper-deck seats should be protected against wind, rain and very hot sun, so that all seats will be usable and salable in all seasons. In a 64-passenger motorbus, 38 seats or approximately 60 per cent of the total are on the upper deck, and the inability to use these seats because of weather conditions entails a serious monetary loss to the operating company and causes great inconvenience to regular patrons that must find other means of getting to or from their destinations. This condition cannot continue to exist if the motorbus is to be considered as a bona-fide all-weather agent of transportation.

The rear platform should be so constructed as to permit the P-A-Y-E system if the operators desire it. The street-railway companies will be the future operators of motorbuses and, as most of them are already committed to this system of fare collection, they will undoubtedly use it on their motorbuses. This system undoubtedly is the surest way for the company to get all the fares, and it keeps the conductor on the rear platform at all times, where he can assist the driver by signals when in traffic or when turning corners, and can prevent accidents caused by boarding and alighting while the motorbus is in motion.

[1] M.S.A.E.—General manager, Philadelphia Rural Transit Co., Philadelphia.

A front-door exit from the lower compartment, to facilitate unloading, seems to be a desirable addition. We have this feature on the motorbuses designed for our own company but as they have not yet been operated on heavy-traffic downtown lines, I am unable at this time to say whether the mechanical complication is warranted. We hope, however, to operate double-deck motorbuses on certain routes at certain times with one-man operation and, of course, in this case the front door will be necessary, for the rear door is locked during this time.

Double-deck motorbuses should be built in accordance with the latest developments of the art. Nothing but the finest materials and the highest class of workmanship should be used in their construction. When we consider that these vehicles have a very considerable useful life, the initial cost, within reasonable limits, is of no great consequence.

Maintenance Costs Vary with Locality and Type of Equipment

Certain builders advertise the fact that their motorbuses can be maintained for so many cents per bus-mile. Prospective purchasers, however, cannot make comparisons between different vehicles on this information and gain any good from it, because, first of all, they would have to know what items of expense are included in this figure, and the prices paid for labor and materials.

Almost every item of expense under maintenance and transportation varies according to the locality and the type of equipment used. Locality determines the cost of labor and material; equipment will determine the ratio between maintenance and transportation, according to the nature of the routes operated.

Nothing is to be gained in obtaining a very low maintenance-cost at the expense of an added transportation-cost, nor is lowering one item of transportation an advantage if it will increase another.

For instance, a certain type of motorbus operating over Broad Street in Philadelphia might cover 5 miles per gal. of gasoline and be able to maintain a schedule speed of 12 m.p.h. At 20 cents per gal., the cost of fuel would be 4 cents per bus-mile. With the drivers and conductors getting say 70 cents per hr. the cost of platform-help would be 11.7 cents per mile. Another type of motorbus might be able to do 7 miles per gal. of gasoline and at the same price would cost 2.86 cents per bus-mile for fuel, a saving over the first motorbus of 1.14 cents per bus-mile. The second motorbus might be capable of maintaining a schedule speed of only 9 m.p.h., which would make the platform-help cost 15.55 cents per bus-mile, a loss on the platform-help item of 3.85 cents per bus-mile, which, taking the gain in the fuel item into consideration, would show a net loss in the total cost of operation of 2.71 cents per bus-mile.

It is the total cost of operation that the operator is interested in, and I believe that the industry in general would be benefited if builders would quote in their advertisements the figures obtained in actual operation and be prepared to furnish the detail figures from which the total operating-costs were obtained.

Maintenance Should Forestall Trouble

The next requirement is a system of maintenance to take care of the vehicles so that they will always be in first-class condition. Experience has taught us that anticipating trouble, or rather taking steps to forestall it, is the logical way and, as wear and tear is practically in direct proportion to the miles operated, we maintain our motorbuses on a mileage basis. Large operating companies, such as the Fifth Avenue Coach Co., the Chicago Motor Coach Co. and the Detroit Motorbus Co., divide maintenance into two main divisions:

(1) General overhaul
(2) Annual overhaul

The first consists of a thorough inspection of the whole vehicle every 2000 miles. This work is done over pits provided for the purpose. The vehicle is thoroughly lubricated, the oil in the crankcase is changed, transmission oil is added to both the transmission and the rear axle if needed, the spring leaves are spread and greased and every lubricator is connected to the power gun to replace the lubricant used since the previous general overhaul. The engine is tested for loose bearings, carbon is scraped out, if necessary, and spark-plugs are cleaned. The magneto or distributor-head is cleaned and oiled, and the points looked to. All nuts, and especially the body hold-down bolts, are tested with a wrench for slackness. Gasoline lines and strainers are cleaned out. Light and bell circuits are tested, route and destination signs carefully examined and oiled and the whole body, especially the seats, both upper and lower, is examined for possible loose screws and bolts. Tires are examined for the presence of stones and other foreign substances, and all that have flat spots or are below gage are removed and replaced with new tires. Finally, the whole interior of the vehicle is thoroughly cleaned, the white enameled ceiling and the woodwork being washed and the seats cleaned with a vacuum cleaner.

As its name implies, the annual overhaul is done every 12 months. At this time the whole vehicle is disassembled. The body is sent to the body shop to be thoroughly rebuilt. If necessary, it is torn down to its framework and new posts, sills, and the like, are installed. Sills and posts are examined particularly for dry rot and the parts thus affected are removed and replaced by sound ones. All traces of temporary repairs that have been made, because of accidents, are removed so that when the body leaves the body shop it is virtually as good as new. Repainting and revarnishing make it practically new. All the cardinal units, such as the engine, the clutch, the transmission, the front and the rear axles and the steering-gears, are completely rebuilt, all worn or defective parts being replaced. No care is taken at this time to put the same units back, as all units are interchangeable and the substitution of other rebuilt units hastens the job. The rest of the chassis is given the same care as the cardinal units so that when the chassis is again ready to receive its body it also is as good as, or even better than before. I say better, because at this time any improvements that have been developed since the last annual overhaul are incorporated into it. This puts off farther into the future the day when the vehicle will have to be scrapped, not because it is no longer serviceable but because it is obsolescent.

Unit Overhaul Substituted for Annual

The annual overhaul is general practice, as I said before, with the largest companies in this Country, as it is also with the largest motorbus company in the world, the London General Omnibus Co. It therefore certainly has precedent and successful operation to substantiate it. I have planned, however, to substitute for it in Philadelphia a system of unit overhauls. In this system the vehicle is divided into the following units, which are numbered:

Body
Engine
Clutch

Transmission
Differential Assembly
Generator
Starter
Magneto
Distributor
Battery
Chassis Assembly, including all parts not specified above

Each of these units is put on a predetermined mileage basis that is a multiple of the general overhaul period of 2000 miles. Proper records are kept as to the location of each unit, the chassis assembly being the key, and the mileage of each unit is posted daily. It is then the duty of the mileage clerk to notify the shop foreman each day what motorbuses are due for a general overhaul and what units for a unit overhaul. The shop foreman during the overhaul period removes all such units and replaces them with rebuilt ones, sending the removed units to the unit-overhaul department where they are completely rebuilt by specialists in their particular lines.

The chassis assembly and the body are put on the same mileage basis, as the work of removing the body is such that it would be uneconomical to remove it twice, once to overhaul the chassis assembly and once the body.

The main reason that I am in favor of this system is that time is not a good basis on which to do this work, for motorbuses in a fleet perform widely different mileages in the same period. I have seen some motorbuses come in for annual overhaul after a mileage of 75,000 and others after a mileage of 40,000. These differences are due to schedule requirements. If in the first case the motorbuses were capable of running 75,000 miles, the second motorbus was brought in too soon; and, inversely, if they were due for an annual overhaul at 40,000 miles, then the first motorbus was 35,000 miles overdue and unfit for service during the last 35,000 miles of its performance.

All units should not be on the same mileage-basis. A well-designed Knight engine should run for 50,000 miles without a thorough overhauling, but I should not consider it good practice to run the magneto or generator for the same period. These mileages, however, can be determined only by actual practice and from an intimate knowledge of the equipment operated. A conservative mileage allowance should be given at the beginning and increased as experience shows the possibility of doing so.

Having secured the right equipment, and a proper system of maintenance, well executed, to keep it in first class condition, we next need the right men, properly trained, to operate it.

What Schedules Should Do

Correctly built schedules are the foundation of the transportation department. These schedules should be built

(1) To supply the riding public with adequate service when and where it is needed
(2) So that the runs will be such that the drivers and conductors will receive a fair day's work without having to be on duty an unnecessarily long overall period. As many runs as possible should be semi-straight, that is to say, with "swings" of 30 min. or less. I am absolutely opposed to strictly straight runs, for no man can work efficiently 9 hr. without some break for food and refreshment
(3) To assure a profit to the company. A carelessly built schedule can cost the company hundreds of dollars more per day to operate, without giving good service to the public, than another that would give good service and cost less

Schedules are governed by two main factors; (*a*) the volume of traffic to be handled and (*b*) the speed that can be made from terminal to terminal. Both these factors, however, are variable and fluctuate throughout the day. These fluctuations can, to a major degree, be calculated from observations and be provided for by the schedule department by varying the number of vehicles in service and the running time during different periods of the day.

Circumstances, however, upset even the best planned schedules and cannot be foreseen or provided for by the schedule department, such as fires along the routes, unexpectedly heavy riding requiring more service than is available, falling off of riding because of sudden rainstorms' causing too much service, delays due to mechanical failures' causing extended headways, accidents and the like.

The motorbus is a more flexible agent of transportation than is the street-car, because it is not confined to rails, can therefore pass another motorbus that is either late or disabled, and can turn at any point on the route. It can also leave the regular route and detour around a fire or other obstruction, without an appreciable loss of time. Properly trained starters and inspectors can take advantage of all these facts and can compensate for all the irregularities in the service that are caused by unforeseen or unexpected circumstances, thus ensuring even headways, or nearly so, under all circumstances. Even headways are the chief outward indication of a properly managed motorbus line.

The Bus Crews and the Public

We now come to the drivers and the conductors, the men on the firing line, as it were. Too much care cannot be given to the selecting and training of these men as they form the personal contact between the company and its patrons; and it is on the attitude of these men toward the public that the public will judge the company. "Courtesy" should be their watchword and their creed and they should practise it under all circumstances, however trying they may be. It is an easy matter to be courteous to a man who is courteous to you; and there is no particular credit in doing anything easy. Accomplishing a difficult task, however, is a thing to be proud of and is worthy of accomplishment; being courteous to a "grouch" is a feat worthy of accomplishment, and every time a conductor does this he performs three things:

(1) He makes the "grouch" ashamed of himself and unlikely soon to repeat the offense
(2) The conductor acquires a feeling of adding self-respect and a pleasant feeling of having nobly done his duty
(3) The company acquires a "booster" and loses a "knocker"

Courtesy is required of drivers as well as of conductors. If the drivers of motorbuses are not considerate to the drivers of other vehicles on the road they very soon alienate the good feeling of a large and influential body of citizens. Motorbuses are large vehicles and can be objectionable to other motorists if the drivers of them do not practise courtesy. Consideration for the rights of others and even the waiving of their own rights at times, will make friends both for themselves and for the company, and both may find themselves in need of this friendship at some time. Courtesy on the part of all drivers of vehicles toward one another would eliminate 90 per cent of the traffic accidents.

Highways and Traffic

By Major F. S. Besson, U. S. A.[1]

Washington Section Paper *Illustrated with* Photographs and Drawings

DIVIDING streets into three classes, rapid-transit and local streets and traffic highways, the author defines these terms and, using the original plan of the City of Washington and present street conditions there as a basis of illustration, comments thereon and shows plainly how important adequate city planning is in its bearing on the traffic problem and what great foresight it requires.

Stating that, from a traffic standpoint, an intersection consisting of more than two streets is objectionable, problems of city planning in relation to block and street areas are mentioned and illustrations given. Street grades and street design are discussed; proper vehicle-width and vehicle-length are considered as factors of traffic congestion. The design of rapid-transit streets and street development are treated somewhat specifically. Other divisions of the subject include the maximum economic width for a traffic highway, pavement development, traffic control, one-way traffic on streets and the influence of truck capacity on traffic.

SUITABLE highways, that will accommodate the increasing demand for rapid transportation and permit control of the traffic thereon, constitute a serious and very complicated present-day problem. Aside from the type of highway construction employed and the character of the vehicles, the relation that any given highway bears to other highways, the kind of traffic that it is called upon to bear, its gradients and other basic factors, have such an important influence on successful traffic control as to cause me to place greatest emphasis upon them for the purposes of this discussion. The illustrations cited are mainly from the City of Washington, which outgrew its original plan about 30 years ago and therefore offers many highway and traffic problems that are due to lack of sufficient foresight.

Streets may be divided into three classes; rapid-transit streets, local streets and traffic highways. If properly laid out, rapid-transit streets invariably become business streets. The motorist should travel thereon only to transact business. Local streets are residential, commercial or industrial in character; the motorist should use such streets only in the connection for which they are designed. Traffic highways exist primarily for hauling and motoring. They should afford convenient connections between residential, commercial and industrial districts and between cities and the country that surrounds them. Some may be portions of State truck-highways and bypass the business sections of the city entirely.

The City of Washington's original plan, by L'Enfant, was for "a city of magnificent distances"; it was looked upon as the exaggerated dream of an idealist for many years. Its appearance from an altitude of 15,000 ft. is shown in Fig. 1. A study of this plan will give anybody who is interested some understanding of the very difficult highway situation in Washington that must be remedied in the near future. For example, the City of Washington has many short sections of highway, but no out-and-out traffic highways. Even 16th Street is not satisfactory; it ends in a *cul-de-sac*. Conditions are bad at Columbia Road, at U Street and at Scott Circle. Despite the fact that the lettered streets are too close together, there are intermediate ones such as Church, Corcoran and Riggs streets. Instead of being able to speed on 16th Street, a driver must slow-up every 200 or 300 ft. on account of street intersections.

Fig. 1—Looking Down on the City of Washington
The Photograph from Which This Illustration Was Made Was Taken at an Altitude of 15,000 Ft. and Shows How the Original Plan of L'Enfant for a City of Magnificent Distances Has Been Developed

When the one available traffic highway becomes overburdened, the overflow of traffic takes to rapid-transit and local streets in violation of the principle that vehicles should not travel on such streets except in connection with business to be transacted thereon. Business firms then complain that congestion on the roadways interferes with the transaction of business. Often the traffic engineer looks no farther than to these rapid-transit and local streets for the trouble, whereas it originates because of insufficient traffic highways. The remedy lies in supplying more traffic highways.

The circles that L'Enfant used so effectively from the standpoint of beauty in his street plan for the City of Washington are, from the traffic standpoint, a detriment. No one could have foreseen the traffic conditions of today and, if L'Enfant passed on to the present certain traffic situations that are difficult to improve, he cannot be censured. But we cannot look in that spirit upon our failures today not only to provide for the present and the future but to correct the mistakes of the past.

Street Intersections

From a traffic standpoint, an intersection consisting of more than two streets is objectionable. From the standpoint of appearance, very beautiful effects can be obtained. Where there is sufficient area for the installation of a central circular park, and rotary traffic to the right can be established, as shown for Scott Circle, in Fig. 2, conditions are bettered.

[1] Acting engineer commissioner of the District of Columbia, City of Washington.

FIG. 2—VIEW OF SCOTT CIRCLE, CITY OF WASHINGTON

From a Traffic Standpoint, an Intersection of More Than Two Streets Is Objectionable; Although from the Standpoint of Appearance, Very Beautiful Effects Can Be Obtained. Conditions Can Be Bettered if There Is Sufficient Area for a Central Circular Park and Rotary Traffic Can Be Established to the Right as Shown

If there is any latitude in making a choice, a car line should not be placed on a street that passes through a common intersection with two other streets. Such an intersection as that shown in Fig. 3 was very dangerous for pedestrians and for vehicle operators prior to the installation of the four island-platforms illustrated. Close to 2000 vehicles pass on the two streets in 1 hr.

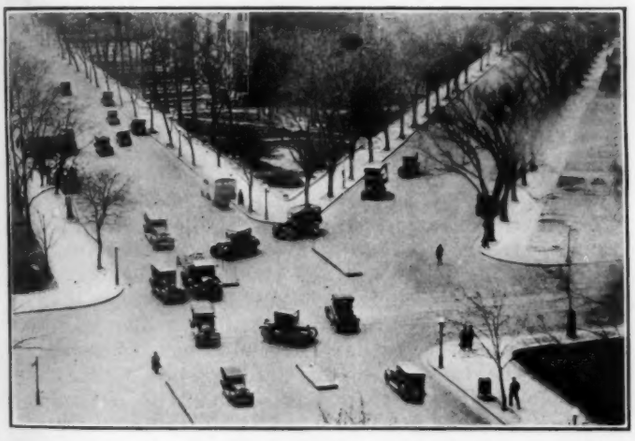


FIG. 3—A TRAFFIC SITUATION THAT SHOULD BE AVOIDED

A Street Intersection of This Type in Which a Car Line Passes Through a Common Intersection with Two Other Streets

across the car tracks, during business periods. The islands do not interfere with traffic on the most important of the three streets, which is at right angles to the car-line, nor with that on the car-line street, and traffic on the diagonal street is directed into well-defined lanes.

In laying out city blocks, certain principles must be remembered. For some streets, it is desirable to discourage traffic except that having to do with abutting property. The roadways of these streets should be wide enough for local requirements only and need not be continuous for long distances. For others, through traffic is a prime consideration, and interruptions to safe and rapid travel should be a minimum.

In the conventional drawing of Fig. 4, notice how Diagonal Avenue makes a three-street intersection at every third intersection. The three named streets in Fig. 4 are highways such as I have mentioned. Such conditions can be bettered as shown in Fig. 5. By arranging the local streets to provide the block areas shown, passage along Diagonal Avenue can be improved and spaces 800 ft. instead of 200 ft. long secured in which traffic can speed-up.

Even a simple intersection of Diagonal Avenue with another street has objectionable features. Where an acute intersection is necessary, it should be improved by installing a long island-platform as shown in the right portion of Fig. 6. This island interferes in no way with through traffic on the more important of the

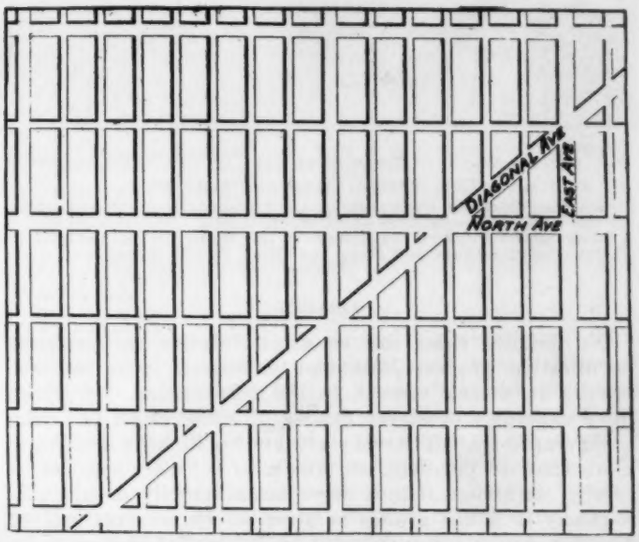


FIG. 4—HOW A DIAGONAL STREET MAKES FOR TRAFFIC CONGESTION

In the Drawing North Avenue Represents a Rapid-Transit Street; East Avenue a Local Street and Diagonal Avenue, a Traffic Highway. The Last-Named Thoroughfare Makes a Three-Street Intersection at Every Third Intersection

two traffic highways and conforms to the basic principle of traffic regulation which is: Make your vehicles pass in definite streams and cross other traffic streams at right angles.

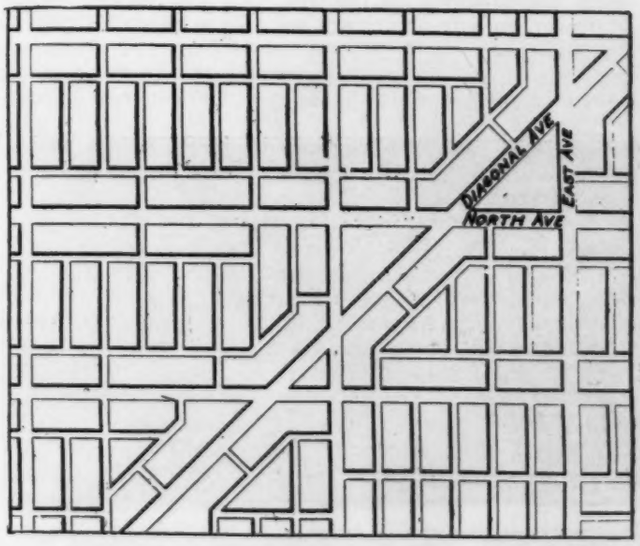


FIG. 5—HOW A DIAGONAL STREET CAN BE LAID OUT TO SPEED-UP TRAFFIC

By Arranging the Local Streets To Give Different Sizes and Shapes of Blocks the Distance Between Street Intersections on Diagonal Avenue Is Increased from 200 to 800 Ft.

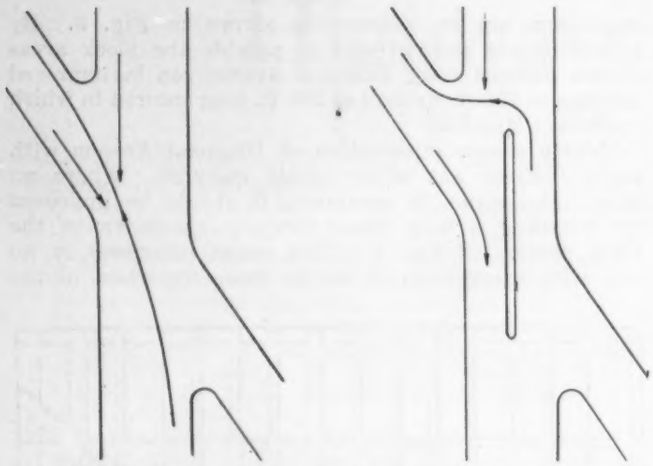


FIG. 6—TWO WAYS OF ROUTING TRAFFIC AT THE INTERSECTION OF TWO STREETS AT AN ACUTE ANGLE

In the Left Diagram the Traffic on the Diagonal Street Crosses That on the Other Thoroughfare at an Acute Angle. The Installation of a Long Island-Platform as Shown at the Right Forces Vehicles To Follow Definite Lines and Cross the Other Traffic Streams at Right Angles

GRADES

No definite rules can be given relative to maximum permissible grades. Judgment alone can gain the best results in fitting streets to the terrain. A few cities have examples of street grades of close to 20 per cent. Some rapid-transit streets are known to have grades of more than 10 per cent, on which, of course, operation is costly. A street cannot serve satisfactorily as a traffic highway if it has grades as steep as 10 per cent. Even 6 to 8-per cent grades are undesirable, but they may be used for short lengths if lesser grades are impracticable. If they continue for more than one block, 6 to 8-per cent grades will slow-up traffic markedly. Grades of from 4 to 6 per cent are proportionately less desirable, while any grades up to 4 per cent may be used freely and without hesitancy for traffic highways.

It is recognized that the steeper the grades are, the greater motor-vehicle operating-costs become; even maintenance costs increase because the more work that is done, the more will be the wear and tear on the vehicle. However, so long as drivers are able to climb hills easily on high-gear or, if stopped, to pick-up and shift into high speed, no time is lost, nor is the traffic capacity of the street lessened. These are points of real importance to the motor-vehicle operator as compared with small and intangible increases in fuel consumption and maintenance costs.

FIG. 7—SUBSEQUENT BUILDING OPERATIONS FREQUENTLY REDUCE THE RESERVE WIDTH THAT HAS BEEN LEFT TO CARE FOR THE TRAFFIC OF THE FUTURE

Originally This Narrow Roadway Street Had a Reserve Space for the Expansion of the Roadway and Sidewalk Width, but the Construction of a Large Apartment House Blocked All Future Plans

The grades that have to be adopted depend to a great extent on the nature of the terrain. Much foresight is necessary in this respect, for considerable money has been spent in correcting at a later date the "follow-the ground" policies of earlier design. The needs of traffic are of first importance in the establishment of grades on rapid-transit streets and traffic highways. On local streets, the needs of abutting property are given greater consideration, though intersecting traffic highways or rapid-transit streets may definitely fix the grades on local streets for short distances.

Whether or not it will be feasible to develop an area often depends upon the grades established for the surrounding streets. Suppose a property has a hill 12 ft. above grade and a hollow 12 ft. below grade. At 45 cents per cu. yd., this property can be graded by placing a charge of but 10 cents per sq. ft. on the land. If this land has a low market-value, perhaps even less than 10 cents per sq. ft., it is evident that the establishment of street grades necessitating such grading would be ruinous to the property. On the other hand, if the land were of much greater value, the 10 cents per sq. ft. for grading might be of little or no significance.

As a general principle, grades should follow the trend of the terrain. While the basis of the highway system of a city should be a rectangular plan, such departure therefrom should be made as will facilitate traffic, aid real-estate development and simplify drainage. Real-estate operators should be encouraged to develop property along natural lines to the fullest extent of their financial and artistic abilities, so long as traffic and drainage requirements are given commensurate consideration. In all developments there is an economic limit beyond which it is not advisable to go.

STREET DESIGN

The width of streets is one of the fundamentals vitally affecting the expansion of cities. While it is a mistake to make streets too narrow, it is also a mistake to make them too wide. The average portion of the total area of a city that is occupied by its streets is more than 30 per cent. If streets are unnecessarily wide, land that otherwise would be available for buildings is wasted. A street is the full space from building-line to building-line. Normally, this width is occupied by a roadway, curbs, tree spaces, sidewalks and the parking or terraces in front of the buildings. Space other than that used for vehicles and pedestrians is extra or reserve width. It is provided as a matter of civic pride to add beauty and comfort and to permit the expansion of roadway and sidewalk width to accommodate future traffic. In explanation, Fig. 7 is shown, illustrating a narrow roadway having extra and reserve width as built upon originally, but an apartment house has been built right up against the sidewalk. No condemnation jury would find the benefits equal to the damages in order that this street might be widened; it is thus set back definitely and permanently and can never be made wider than it is.

VEHICLE WIDTH AND LENGTH

The use that can be obtained from a given width of roadway depends upon the width of the vehicle which, except for street-cars, should be limited to not more than 7½ ft. Permits may be granted for wider vehicles, subject to restrictions as to the routes to be followed and the time of day during which passage is to be made.

Many States place the limit of width of vehicle at 8 ft. I feel that 7 ft. is the proper width, because practically all our streets are designed upon that basis. There are, however, so many vehicles now in existence, that are 7½ ft. wide that I feel constrained to raise my limit to that width. On Seventh Street in the City of Washington an ordinary passenger-car can pass between the cars parked at the curb and the street-car, but an over-wide truck causes the condition shown in Fig. 8. The maximum vehicle-width of 7½ ft., inclusive of its load, must be set for all future time. Engineers need some fixed maximum unit of vehicle width if roadways are to be designed logically.

Length of vehicle will also need restriction in the near future, especially if the use of six-wheel trucks and trailers develops. In turning a corner, an over-long truck is likely to swing wide, take too much space and cause damage to other vehicles. Also, as illustrated in Fig. 9, too long a vehicle, such as the bus parked at the curb parallel with shorter vehicles, entirely closes

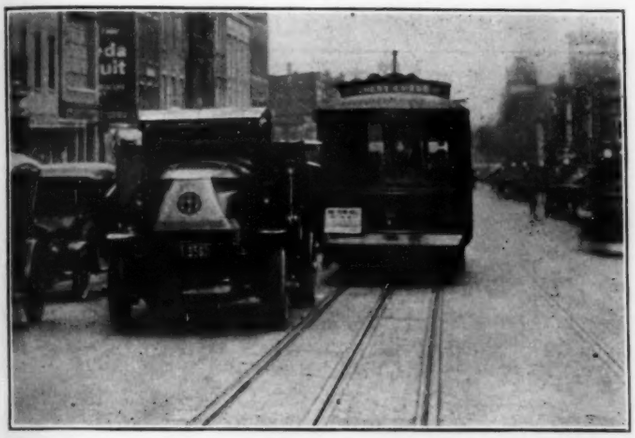


FIG. 8—AN EXTRA-WIDE VEHICLE CAUSES TRAFFIC CONGESTION ON STREETS HAVING CAR TRACKS

A Passenger Car Can Pass a Vehicle Parked at the Curb Without Encroaching on the Street-Railway Tracks, but an Over-Wide Truck Cannot Do So and Interferes with Street-Car Operation

the traffic lane that must be held open between cars parked at the curb and the street-cars.

RAPID-TRANSIT STREETS

In laying out rapid-transit streets, provision should be made for double street-car tracks and, after the business character of the street has developed, a roadway of at least 54 ft. should be available. That is the minimum width permitting free passage between street-cars and vehicles parked at the curb. This street width allows the installation of car-loading platforms, so that vehicles can pass between them and the curbs while the street-cars are taking-on and discharging passengers. Provision of car-loading platforms such as those shown in Fig. 10 is very important. Not only are people protected but vehicles are afforded a freedom of movement that adds greatly to the traffic capacity of the street.

A width of 50 ft. is not an economical one for a rapid-transit street, because vehicles cannot pass satisfactorily between the street-car track and vehicles parked at the curb. An addition of an extra 1 ft. or more on each side of the 54-ft. minimum width adds to the comfort of traffic and somewhat to safety. Further widening within a certain range, for instance, to 65 ft., is not economical; it is too narrow for three lines of traffic between the street-car track and the curb and serves two lines of

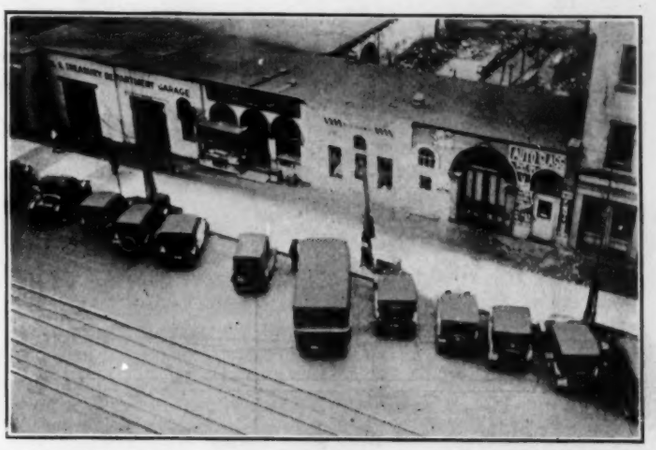


FIG. 9—VEHICLE LENGTH ALSO HAS A BAD EFFECT IN SLOWING-DOWN TRAFFIC

The Parking of a Long Vehicle at Right Angles to the Curb Entirely Closes the Traffic Lane between Cars Parked at the Curb and the Street-Car Tracks

traffic not much better than a width more nearly minimum.

For streets of greater importance, a step-up to a roadway approximately 72 ft. wide is necessary. This provides width enough to accommodate two streams of traffic between vehicles parked at the curb and the street-cars. However, such use is curtailed because of the tendency of traffic to travel in the center of the available space in single file. An excellent plan for using a 72-ft. roadway on which is a street-car line is to stop vehicles either at an angle or perpendicular to the curb, rather than parallel thereto. This not only gives shoppers increased facilities but allows trucks to unload merchandise to advantage. Further, this plan is looked upon with much favor by business houses that abut the street. At street-car loading-platforms, vehicles can stop parallel to the curb and still leave a free passageway for other vehicles.

STREET DEVELOPMENT

At times, street-car lines tap sections of a city that are of such an undeveloped character that a single track suffices for rapid transit, and a narrow temporary road-

FIG. 10—CAR-LOADING PLATFORMS SHOULD BE PROVIDED ON RAPID-TRANSIT STREETS

The Installation of These Platforms Not Only Protects the Would-Be Passengers from the Vehicles, but the Latter Also Are Afforded a Freedom of Movement That Adds Greatly to the Traffic Capacity of the Thoroughfare

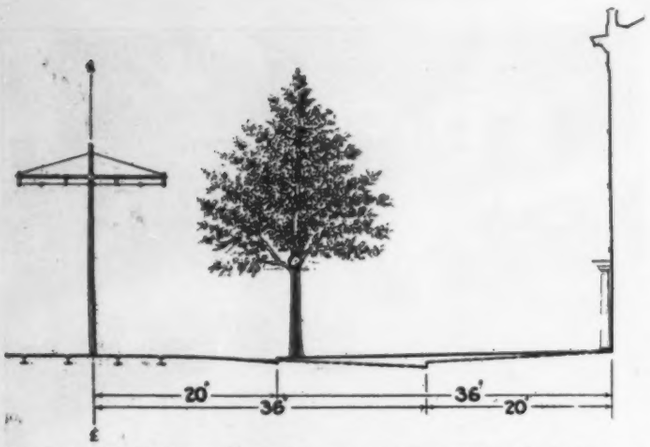


FIG. 11—SUBSEQUENT WIDENING OF A STREET WILL DESTROY THE IMPROVEMENTS PREVIOUSLY PLACED THEREON

In the Case Illustrated Increasing the Width of the Roadway from 40 to 72 Ft. Would Destroy the Sidewalk and Eliminate the Fire Hydrants and the Lighting System and the Trees. To Avoid Such a Condition All Improvements Should, as Far as Practicable, Be Installed on the Permanent Line and Grade when the Street Is Originally Laid Out

way on one side of the track is adequate for other traffic. The sections grow and double track is needed; residences abut the street and sidewalks and curbs and an improved roadway are required. It is at this latter stage of early development that the highway engineer must give most thought to the design of the street. The abutting residences are to be replaced later by business houses but, because of the immature character of the street, a minimum width of roadway of 40 ft. may be adopted. Less width is not warranted, because safe and free passage of street-cars and vehicles is endangered; but, with a 40-ft. width available, one free line of traffic on either side of the street-cars is practicable, although vehicles cannot pass between the street-cars and vehicles parked at the curb. Further, motor vehicles must stop when the street-cars take-on or discharge passengers. However, these are delays that may be considered justified, because the total volume of traffic is relatively small.

There are certain disadvantages connected with a narrow development for the primary stages of a rapid-transit street. When first installed and so far as practicable, improvements should be placed true to permanent line and grade. Trees, planted when the character of the street is residential, should remain after the transition of the street to business purposes. Fig. 11 illustrates how, with a 40-ft. roadway, its widening to a 72-ft. roadway would destroy the sidewalk and eliminate the fire hydrants, the lighting system and the trees that have taken 20 or more years to grow. It is necessary in this case to bring the road crown along the dotted line.

How a rapid-transit street should be developed from the day when only an 18-ft. roadway in either direction is necessary can be seen in Fig. 12. In its completed form, the roadway would be 72 ft. from curb to curb. During the interim, a 36-ft. reserve width or parking space can be devoted ultimately to rapid-transit tracks. Space is provided between the tracks and the curb for shrubbery and the trees are located permanently, as well as the water and lighting systems. When the entire width of roadway is needed, the reserve section of roadway is carried through the parking, the curb removed, the track space shown in Fig. 13 is paved and a 20-ft. sidewalk space for business purposes is still available.

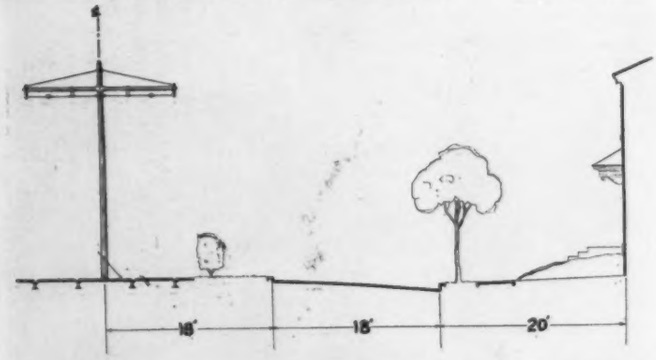


FIG. 12—HOW A RAPID-TRANSIT STREET CAN BE DOUBLED IN WIDTH ECONOMICALLY

Originally the Street Had an 18-Ft. Roadway in Either Direction, and When Completely Developed the Street Would Measure 72 Ft. from Curb to Curb. At First the 18-Ft. Strip Adjoining the Trees Would Be a Reserve or Parking Space That Later Would Be Converted into a Roadway, While the Original 36-Ft. Roadway Would Be Given Over to Street-Car Tracks Exclusively

MAXIMUM ECONOMICAL WIDTH

The limit is approximately 56 ft. for a traffic highway. Boulevards might be included in the general term "traffic highway" but need not always be subject to the same restrictions as regards traffic accommodations and economy. If more capacity is desired for a traffic highway than can be furnished by a 56-ft. roadway, relief is obtained better by the adoption of an additional highway rather than by making the single roadway wider.

FIG. 13—A TYPICAL EXAMPLE OF A STREET, THE WIDTH OF WHICH CAN BE INCREASED

When the Full Width of the Street Is Needed the Space between the Tracks Can Be Paved

A width of less than 56 ft. is, in general, not justified for a traffic highway. For instance, 16th Street in the City of Washington, which is 50 ft. wide, has sufficient room for five lines of traffic; but no decision can be made as to which direction the fifth line should take. Thus, only four lines of traffic can be realized; a line at each curb and two central moving lines. The two central lines actually spread over enough space for three lines, and this is not economical. Unless a roadway permits two unhampered lines of moving vehicles in either direction, it cannot serve satisfactorily as a traffic highway.

PAVEMENT DEVELOPMENT

In the preliminary stages of development of a traffic highway, a high type of expensive pavement for the full width is not justified. One plan is to use a cheap construction, spreading the money thinly over a large area. This gives a surface with a probable life of from 10 to 15 years, but having high yearly maintenance cost that

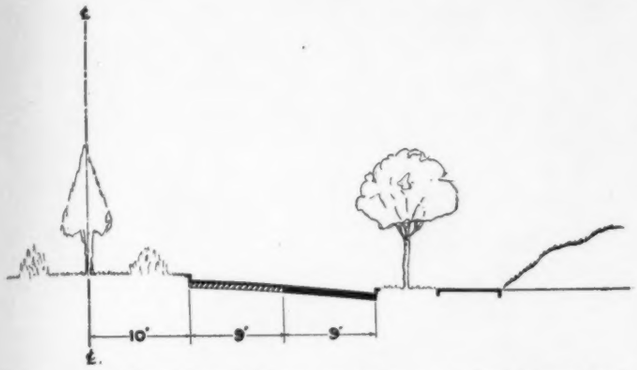


FIG. 14—AN ECONOMICAL METHOD OF PAVEMENT DEVELOPMENT FOR A TRAFFIC HIGHWAY

In This Scheme the Trees Are Planted in the Initial Stages of Road Development and the 9-Ft. Strip Adjacent to the Curb Is Paved With Concrete, the Space to the Left That Is Only Used for Passing a Vehicle Being Covered with Gravel, Cinders or Similar Material. When Traffic Conditions Warrant a Concrete Pavement Is Laid on This Strip, Thus Giving an 18-Ft. Roadway on Each Side of the Parked Central Portion. At Such Time as the Entire Width of 56 Ft. Is Required This Central Parking Is Replaced by Pavement

increases rapidly in amount as the pavement grows older and the traffic increases.

A better plan is illustrated in Fig. 14, the width being 56 ft. from curb to curb and the trees being planted in the initial stages of road development. A 9-ft. strip is paved with concrete; inside that, so that vehicles can turn out for passing, gravel, cinders or the like can be used until traffic conditions warrant replacement of the cheaper strip with concrete, at which time there will be an 18-ft. roadway on either side of the parked central portion. The central parking should be removed and the space paved, when utilization of the full 56-ft. width becomes necessary. This progressive development from the 9-ft. to the 18-ft. and then to the 56-ft. width permits construction to be paid for in installments commensurate with the volume of traffic that is served.

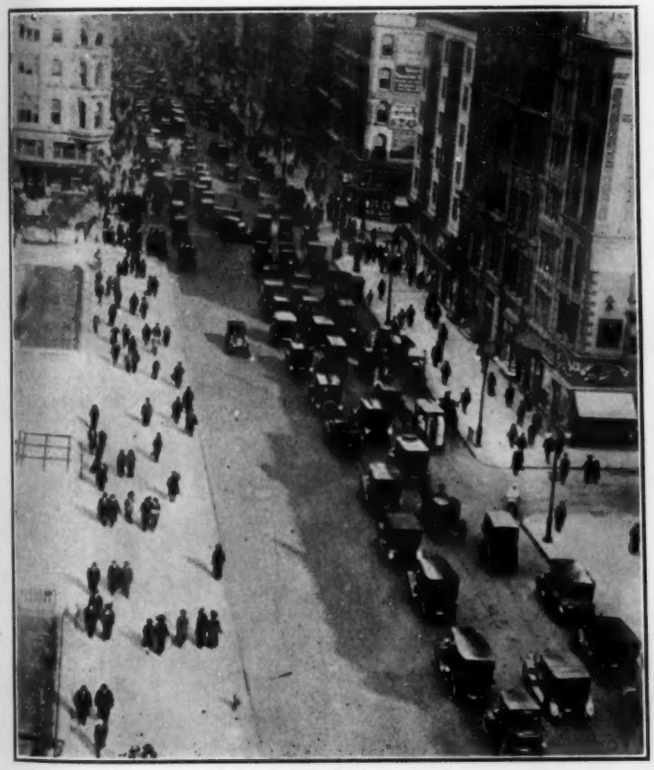


FIG. 15—LOOKING NORTH ON FIFTH AVENUE, NEW YORK CITY, FROM 40TH STREET

The Photograph, from Which This Illustration Is Reproduced, Was Taken before the Traffic Control Towers Were Installed. These Towers Control Vehicular Traffic between Washington Square and 59th Street, a Distance of Practically 3 Miles, as A Unit. Before the Erection of These Towers Separate Traffic Regulations Were in Force at Each Street Intersection with the Result That One Block Would Be Open to North and South Traffic, While the Next Would Be Closed. This Condition Led to Congestion on One Half of the Street and No Traffic on the Other Half as Shown

TRAFFIC HANDLING

The problem of pavement design to care for the gross weight of transportation traffic adequately is well in hand. To provide economically for the probable volume of traffic is a larger and more difficult problem. A strong

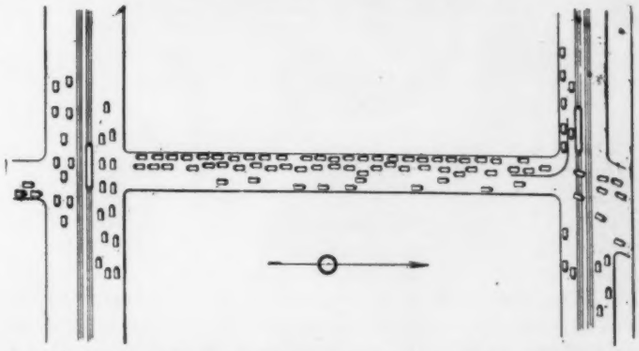


FIG. 16—PROPER TRAFFIC REGULATION SHOULD OPEN BOTH SIDES OF THE ROADWAY SIMULTANEOUSLY

Lack of Synchronism on the Part of Traffic Officers at Adjacent Street Intersections Often Causes Traffic Congestion Due to a Conflict of Signals. This May Result in Feeding More Vehicles into a Line That Cannot Move or One Side of the Street May Clear Out and Become Vacant

pavement can be substituted for a weak one readily; but, unless the plans have been exceptionally well made, it is seldom that a narrow roadway in the heart of a city can be changed to a wide one. Everything possible should be done to realize the full capacity of the roadway widths that are available.

Fig. 15 illustrates traffic conditions on Fifth Avenue, New York City, prior to the installation of traffic-control towers whereby vehicular traffic between 23rd and 59th Streets is controlled as a unit. It shows that much of the time only one-half of the available width was in use when separate traffic regulations were in force at each street intersection. One block would be opened while the next block remained closed. This led to congestion on one-half of the street and no traffic on the other half. Together with the control of pedestrian traffic, the present system has doubled the capacity of Fifth Avenue during rush hours. Today, approximately 15,000 vehicles pass over it in 10 hr. The signal towers not only serve to start and stop traffic but also divide it, separating the north-bound and south-bound streams.

A division of traffic by center-line installations and enforcement of the "keep-to-the-right" principle make for utilization of the maximum capacity of a roadway; otherwise, vehicles spread over too much space. Even when the traffic in one direction preponderates, enough vehicles are traveling at all times to justify center-line installations and the enforcement of the foregoing rule when the total amount of traffic is more than 10,000 vehicles in 10 hr.

Fig. 16 illustrates how traffic on one side of a roadway becomes congested when the traffic-police officers at each end of a block are not synchronized; their signals conflict and one may feed more traffic into traffic that cannot

FIG. 17—TRAFFIC BLOCK ON A 50-FT. STREET WITH CAR TRACKS IN THE CENTER

The Street Is Wide Enough for Two Lines of Passenger Cars To Move between the Car Tracks and the Curb, but if a Passenger Car Stops in the Middle of This Space, the Entire Traffic is Blocked

move or one side may clear out and become vacant. The proper idea is to have them open the roadway simultaneously.

Fig. 17 shows traffic on a car-line street about 50 ft. wide. It is just wide enough for two passenger-cars to move side-by-side between the street-car and the curb, but one passenger-car may get midway of this space as shown and block the entire traffic line. No parking or dead storage of vehicles should be permitted against this curb and two lines of vehicles between the car track and the curb should be maintained and kept moving. Any vehicle that gets on to the white line drawn on the pavement should be forced to make a right-hand turn around that corner. Any vehicle desiring to go straight across when the traffic officer signals should take the line nearest the car tracks and wait, so that the line nearest the curb always will be open.

On a roadway prescribed for the free passage of vehicles between the street-car tracks and the curb, if a truck backs up to the curb to be loaded, the entire traffic of that side of the street becomes blocked. For this reason, whenever business buildings can be provided with arcades for loading purposes underneath their second stories, this is desirable because it leaves the roadway open for traffic and saves labor that is necessary when carrying freight back and forth across the sidewalk.

If a street must be used for loading purposes and is not wide enough to permit free backing-up to the curb, the loading and unloading must be done while the trucks are parked parallel to and against the curb. Such regulations governing general parking on these streets must then be made effective as will assure a satisfactory allotment of space for loading and unloading trucks parked parallel to the curb.

ONE WAY TRAFFIC ESSENTIAL ON THIS STREET-22' WIDE
ON WIDE STREETS ONE WAY TRAFFIC IS NOT NECESSARY
FUNDAMENTALLY ONE WAY TRAFFIC IS UNSOUND

FIG. 18—ONE-WAY TRAFFIC CONDITIONS

In the 22-Ft. Street Shown at the Top One-Way Traffic Regulations Must Be Enforced or a Vehicle Passing between Two Others That Have Stopped at the Curbs Might Collide with a Street Car. On a Wide Street, Such as That Illustrated in the Lower Left Corner, One-Way Traffic Regulations Are Unnecessary and the Drawing at the Lower Right Serves To Bring Out the Handicap Imposed upon Parcel Delivery by the Restriction of Traffic to One Direction Only on Too Many Streets

ONE-WAY TRAFFIC

Under certain conditions, one-way traffic serves a good purpose. If two roadways carrying mostly through traffic lead directly between two sections, one may well be used for traffic in one direction and the other for vehicles moving in the opposite direction. Under war conditions overseas, one-way traffic on certain roads was necessary to serve the battle-fronts properly. Also, when a city has a street but 22 ft. wide in the heart of the business area, as in the upper portion of Fig. 18, one-way traffic is essential. For instance, assume that two-way traffic is permitted on this street; if two vehicles from opposite directions stop at the curb as shown, a third vehicle might take the course indicated by the dotted line and run head-on into a street-car.

On the other hand, the practice of making one-way traffic streets of thoroughfares that are wide enough for two-way traffic, as indicated in the lower left-hand portion of Fig. 18, is wrong fundamentally. In the lower right-hand diagram the arrows show how one-way streets operate to handicap parcel-delivery systems. Such a system of one-way streets not only congests these streets because the vehicles are on the streets twice as long as they would be otherwise, but also they empty traffic into two-way streets that generally are rapid-transit streets having two-way street-car tracks.

INFLUENCE OF TRUCK CAPACITY

In connection with the utilization of the maximum capacity of highways, it appears unwise to eliminate the 7½-ton truck because its load would then be carried by more than one truck and more space would be occupied on the roadway. Truck capacity influences traffic congestion as follows: A 7½-ton truck has an average weight of 11,000 lb. with no load and 27,000 lb. when loaded. Its average length overall is 21 ft. If its load were carried on 1½-ton trucks, five such trucks would be needed. The total weight of the five trucks, unloaded, would be 25,000 lb. as compared with 11,000 lb. for the 7½-ton truck; their length overall on the road would be 138 ft. as compared with 21 ft. for the 7½-ton truck.

Granted that two types of truck are designed equally well, we are not certain as yet that carrying the load on 20 wheels would not do more damage to the pavement than carrying it on four wheels. Certainly, the congestion on the streets would be increased greatly.

Gross weight alone is not the all-important factor. Speed, unsprung weight, the wheel loads, the character of the tire and the tractive stress on the pavement all enter into the matter. Pavements that are strong enough to carry 7½-ton trucks can be built at a reasonable cost. I have examined practically every recent pavement failure in the City of Washington, and in no case could the blame be placed upon the heavy truck.

Engineers need some unit upon which to base design and, having adopted the 7½-ton truck as this maximum unit, the public should be informed that this limit is to continue indefinitely. However, *within the permissible gross-weights for vehicles,* certain regulations are required. A basic rule should be that trucks may not carry more than the weights for which they were built, and in accordance with which weights the owners have paid fees in obtaining operating permits. The automotive industry condemns overloading.

THE DISCUSSION

QUESTION:—Some arterial highways in Cleveland are divided by two lines into three zones so that north and south traffic coming into the city in the morning can use two-thirds of the streets and, going out at night, it can use two-thirds of the street. What is your opinion of that plan?

MAJOR F. S. BESSON:—I have investigated the plan in general and concluded that full width must be available for traffic either way when the traffic exceeds 10,000 vehicles in 10 hr. on a street 56 ft. wide with stopping at the curb, which must be permitted. For instance, East Executive Avenue, in the City of Washington, is advocated by some as a one-way street. Traffic goes down that street in the morning and traffic comes also the other way from the brick yards, coal yards and the like in volume almost equal to that going south.

QUESTION:—Regarding a 7½-ft. maximum width of vehicle, is it possible to accomplish that in any degree? Plenty of 100-in. vehicles, trucks and express vans, are in service in Chicago, but in Montreal they are limited somewhat more in width.

MAJOR BESSON:—It is a matter of limiting the enlargements. In my judgment, it would be better to make the limit 7 ft., but I cannot see how that can be done at this late date. We have to make the limit about 7½ ft. because 7½-ton trucks are just about 7½ ft. wide. Some States make the limit 8 ft. but I do not understand the reason. We put regulations in force in the City of Washington to limit vehicle width to 7½ ft. but people do not seem familiar with them and we have had instances of vehicles wider than that. Some of the buses on the streets probably are wider than 7½ ft. One fuel dealer proposed a vehicle 10½ ft. wide. He wanted to use a 10-ton truck and a trailer and haul 12-ton loads of coal. To get such equipment low enough to go under the chute at the coal yard, he needed to make it wide. By making the limit 7½ ft. we also limit the load, because it is difficult to load much more than 7½ tons on a vehicle less than 7½ ft. wide.

QUESTION:—How do the motor-truck builders regard that width limitation?

MAJOR BESSON:—I am generous in making the limit 7½ ft. Much more money is tied up in roadways already designed than in vehicles already designed. An engineer must have a limit for design purposes. Most motor-vehicles are less than 6½ ft. wide. Why allow a few vehicles to run the limit up to 8 or 9 ft. and thus destroy the whole scheme of city design?

W. S. JAMES:—What about speed regulation in the traffic control in the congested and the outlying districts?

MAJOR BESSON:—On traffic highways, the ideal situation would be to have railroad gates at cross streets; but I fear that can never be done for city streets.

DR. H. C. DICKINSON:—In comparing the 7½-ton truck with lighter vehicles as regards their effect on congestion, are you considering the 7½-ton-truck limit as desirable for all highways or only for municipal highways?

MAJOR BESSON:—Any motor-vehicle regulation should be nation-wide; we should decide on one maximum unit of size, on one width of vehicle, on one system of taxation and on one system of regulation of the vehicles.

PAUL B. LUM:—In that connection and with reference to vehicle speed, is there any definite comparison between the effect of the slow-moving heavy truck and the lighter vehicle as regards the effect on congestion?

MAJOR BESSON:—I think not. In congested areas, all traffic must travel at a very slow speed. For instance, on East Executive Avenue, in the City of Washington, at 9:00 a. m., vehicles seldom if ever go through at 20 m.p.h.; they are traveling about 12 m.p.h., which is the speed of a heavy truck.

MR. LUM:—In the congested portions of New York City, vehicle speeds are practically fixed at about 7 m.p.h by the heavy trucks; whereas, the entire traffic could just as well move at 12 m.p.h.

MAJOR BESSON:—If those loads were carried on double or triple the number of trucks, I think the speed would be the same because the congestion would be so much greater. Vehicles would be on those streets in such great numbers and the distance between vehicles would be so small that they could not speed-up. For a speed of 30 m.p.h., a 100-ft. space is necessary between vehicles; but, at 6 m.p.h. one vehicle can nose right up to another.

THE FARMER'S CONDITION

SO much has been printed in the public press about the farmer's condition that a great many people, especially in the East, are beginning to get the idea that the farmers in the West are all in a deplorable condition. It is true that farmers as well as all other lines of business suffered severely in the period of deflation, but the farmer who conducted his business along proper lines had not purchased high-priced land in the period of inflation and loaded himself with a heavy burden of interest and had not spent his earnings in extravagant living is today in good financial condition. Not only can he meet his obligations but he is in a position to make money. In northwestern Missouri, northern Kansas, southeastern Nebraska and southern Iowa, the basic conditions were never sounder. Land prices have been reduced to a normal point.—Tootle-Lacy National Bank of St. Joseph, Mo.

Discussion of Papers at the 1924 Annual Meeting

THE discussion of the papers presented at the Aeronautic, the Fuel and Engine, the Motor-Truck Transportation and the Production Sessions of the 1924 Annual Meeting included written contributions submitted by members and the remarks made at the meeting. In every case an effort has been made to have the authors of the several papers reply to the discussion, both oral and written, and these comments, where received, are included in the discussion. For the convenience of the members, a brief abstract of each paper precedes the discussion, with a reference to the issue of THE JOURNAL in which the paper appeared, so that members who desire to refer to the complete text as originally printed and the illustrations can do so with a minimum of effort.

The discussion following the presentation of the paper at the Aeronautic Session by Lieut. A. J. Lyon and Samuel Daniels, together with that at the Brake Session following the presentation of papers by Henri Perrot and G. L. Smith was published in the April issue of THE JOURNAL commencing on p. 431. Papers were also presented at the Production Session by A. A. Brown, Joseph Lannen, R. A. DeVlieg and Daniel Meloche. The discussion following the presentation of these papers will it is expected, be published in an early issue of THE JOURNAL together with that of the papers presented at the Motor-bus, the Passenger-Car and the Research Sessions.

FUNDAMENTAL IMPROVEMENTS IN MANIFOLD DESIGN

BY A. M. DEAN, J. W. SWAN AND C. A. KIRKHAM

MANIFOLDS that have been designed as if they were intended to handle a fixed gas and that depend upon application of excessive heat and have not produced satisfactory results. Although heat in a limited amount aids vaporization, it is an agent that must be used with caution. As present-day fuels are composed of volatile constituents blended with the heavier ends, only a part at best can be vaporized and manifolds should be designed so that they will distribute wet mixtures or fog, instead of dry gases, uniformly at varying engine speeds and varying throttle positions. The four elements in the mixture furnished to the engine are air, water vapor, gasoline vapor and liquid particles of gasoline or fog. Liquid particles of considerable volume can be held in the airstream without depositing if the velocity is kept relatively high. But when rapid reversals in the direction of mixture-flow occurs, as in the manifold of a multi-cylinder engine, the particles separate out by gravity and deposit.

An efficient manifold must not only conduct the fuel mixture but must distribute it uniformly in the same condition as that in which it left the carbureter. Manifolds that are designed for maximum power sacrifice performance at low speeds, so that the tendency recently has been to reduce the size of the intake and increase the speed of the mixture to obtain more satisfactory low-speed performance. Efficient operation of a manifold is indicated by increased torque, increased acceleration, economy and ease of starting the engine, while the secondary results to be noted are uniform firing, even when starting cold, and a consequent reduction in the dilution of crankcase oil, lessened vibration and lessened carbonization. Although many engineers have assumed that distribution is equal when the power developed by the several cylinders is equal, this assumption may be in error; the air-to-fuel ratio may vary considerably, yet the power developed remain the same. The most accurate means of determining the distribution is an analysis of samples of exhaust gas taken simultaneously from the individual cylinders. To obtain equal distribution the fuel can best be supplied to the cylinders as a fog and this can be done without the use of heat. An analysis of conventional types of manifold construction shows that almost invariably the lighter fuel-fractions are furnished to certain cylinders and the heavy ends to others.

In the Swan method of distribution the forces, due to the suction of the several cylinders, acting upon the carbureter are all equalized at the top of the riser or metering point of the systems. The result is equal flow in each branch. Also successive flows are always in a different direction from this metering point to minimize inertia effects.

The manifold is a straight-line type of square or rectangular section and the turns are abrupt and at substantially right angles. The flat floor of the square section provides the maximum area for exposing the liquid fuel to the airstream. Among the advantages claimed for a manifold of this type are (*a*) straight-line manifold (*b*) the holding of the atomized fuel from the carbureter in an atomized condition in the airstream to the cylinders and (*c*) low first cost, which in many cases is appreciably less than in manifolds of conventional type. Although heat is not necessary, to realize equal distribution, a certain amount is required to offset the rapid reduction of temperature above the throttle-valve at closed-throttle positions, which normally would cause the temperature to drop below the dew-point. In the Swan manifold the application of a fixed amount of heat of the maximum intensity is entirely automatic in its action because of the difference in the velocity of the mixture at open and part-throttle positions. Curves of brake horsepower, torque and fuel consumption are given to show the comparative operation at various loads of Swan manifolds and those of the conventional type. [Printed in the February, 1924, issue of THE JOURNAL.]

THE DISCUSSION

A. M. DEAN:—Fig. 1 was made since the paper was written. It shows the results of an actual analysis of exhaust gas from an eight-cylinder engine, and is plotted over a Watson graph to show what it is possible to ac-

complish. The characteristic Watson graph is shown by the broken lines. The carbon dioxide, CO_2, approximated the lines closely; but the carbon monoxide, CO, was somewhat wild. We obtained an absolute reading of 14.2 per cent of carbon dioxide, the maximum possible, although that may have been by chance.

A MEMBER:—Should there not be some control of the heat as regards heating up the fuel in the float-chamber by the heat conductivity of the metal manifold to the carbureter?

MR. DEAN:—We have made many tests with and without controlled heat since. We work with the majority of the carbureter manufacturers. At the beginning of our applications of this manifold, the application of heat was frequently left to the builders of the engines. We have found no detrimental effect from the use of fixed heat just above the throttle of the carbureter, provided the jacket is not made too long. We do not want excessive heat; but, at that point, we want to get the maximum intensity of heat. The only time that we obtain any excessive heat in the throat of the carbureter is in dynamometer tests with wide-open throttle and without circulation; it is a condition not realized on the road.

F. E. MOSKOVICS:—About 2 years ago Col. A. H. Hall experimented with various types of eight-cylinder racing-engines in California; the Ballot, the Duesenberg and an engine he built himself. He found unequal compression in the cylinders; for some reason, the outside cylinders and the two middle cylinders had the greatest compression. I will not attempt to say why. This he eliminated by using varying compression pistons.

The Miller engines have a single manifold for each cylinder that is very effective, and the distribution is splendid, as was proved at the 500-mile race. One of the Durant cars driven by Eddy Hearne used four carbureters, but the cars driven by Tommy Milton, Jimmy Murphy and Cliff Durant used eight carbureters. The eight-carbureter engines were 250 r.p.m. faster. Hearne used four carbureters instead of eight because the Miller type of carbureter has a barrel throttle; he was afraid that particles of dust would cause it to stick and thought that fewer carbureters would reduce the chance of having the throttle stick.

The Bugatti car used two carbureters. The cars driven by Sporofski and Alsaga and Prince Gystra were equipped with two carbureters also. The four-carbureter engines were 175 r.p.m. faster than those using two carbureters and, in each case, the cars having the straight-eight manifold were the fastest. These carbureters had a barrel throttle-chamber; they were closely set. When the cars were first built, 122-cu. in. engines were used and the manifolds were rather short. It was found that lengthening the manifolds and bringing them farther down increased the speed by 125 r.p.m.

A MEMBER:—Mr. Dean said that temperature control is wholly automatic. It cannot be entirely automatic in both winter and summer without using some other arrangement.

MR. DEAN:—Very often we follow the recommendation of the carbureter people with whom we are working. We have used the hot-air stove and, in practically all our work, we use the standard commercial carbureters and work with nearly all makes. We have no objection to the use of hot air. It is an advantage in certain makes of carbureter.

A MEMBER:—It seems that no one has taken into consideration that the manifold itself is the "carbureter." We have had reports of many tests and experiences regarding operation in connection with the amount of heat needed; but we find that, once the mixture proportions are fixed and the engine is run under those fixed conditions, the requirements are different in winter. Unless the conditions for which the mixture proportion is fixed can be approximated, it is necessary to add a stove, or to add heat in some way. For instance, one job that was worked out recently could run with a summer carbureter-setting, provided more heat was applied to the intake system; otherwise it was necessary to open the gasoline orifices wider and put more fuel in. That is purely a matter of metering. If the power output is maintained by the application of heat on the riser portion without increase of heat to compensate for the weather change, more fuel is needed. The same thing is more or less true regarding acceleration. The summer setting will not accelerate the engine in winter without the change of heat or some other change. Manifolds themselves are really carbureters in winter, inasmuch as they have a certain accumulation of wet fuel that can be used if it is handled properly.

In another case in particular, having pockets at the ends of the manifold where heat was applied, the wet fuel would collect in them and give tremendous acceleration. Unfortunately, it could not be controlled when the engine was idling. I fail to see how we can expect any manifold to help out the carbureter unless we control the temperatures in winter and in summer. Under what extreme conditions, from cold to hot, has Mr. Dean worked out these tests?

MR. DEAN:—The manifold cannot correct characteristics of the carbureter. All it can do is to accept the fuel conditions that the carbureter delivers and distribute the

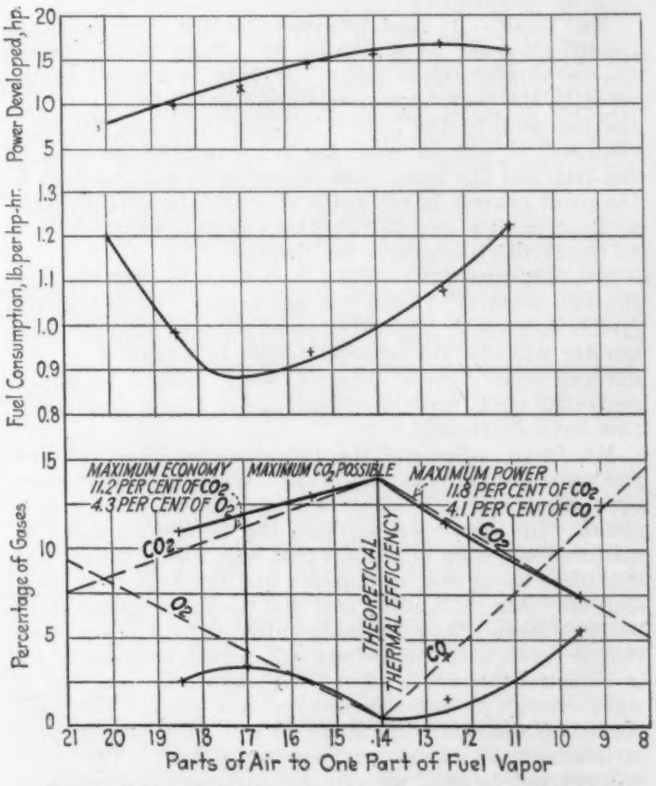


FIG. 1—RESULTS OBTAINED FROM AN EIGHT-CYLINDER ENGINE

The Power and Fuel-Consumption Curves Are Plotted in the Upper Portion of the Chart with the Results Obtained from an Actual Exhaust-Gas Analysis Underneath. The Characteristic Watson Graph Is Shown by the Broken Lines and Provides for an Easy Comparison with What Can Be Accomplished. While the Carbon-Dioxide Lines in Both Cases Coincide Approximately, the Carbon Monoxide Lines Do Not. Note That an Actual Reading of 14.2 Per Cent of Carbon Dioxide, the Maximum Possible, Was Obtained

fuel mixture uniformly. We know that the different carbureters have different characteristics, those are the carbureter problems. We have found a number of carbureters that work very satisfactorily on a manifold without the addition of hot air.

Referring to the types of manifold having a series of pockets, the acceleration seemed tremendous at the time but, when checked by a stop-watch, it was not. After that first "punch," the manifold is cleared out and then the power drops. The manifold I have described takes a very light accelerating-charge; that is, very little fuel is in the manifold itself at any time. A bull's-eye window can be put in one end of it, a light put at the other end, and the actual conditions watched. All that is evident is a little moisture on the walls. Another characteristic of this manifold is that no back drainage occurs when the engine is shut off.

W. G. HEGINBOTTOM:—Mr. Dean stated that the point of greatest refrigeration is just above the carbureter. An ice machine has its point of greatest refrigeration at the nozzle or point of expansion; the same thing applies to the throttle of the carbureter. As the fuel mixture passes the throttle, it expands. My experience has been that the point of greatest refrigeration is at the partly opened throttle.

MR. DEAN:—That is true. The point of refrigeration is at the throttle or just above it. That is where the reduction in pressure and the greatest vaporization occur; so, the nearer we can apply the heat at that point, the better off we are. We apply a maximum heat in the riser just above the throttle.

MR. HEGINBOTTOM:—What is the objection to applying heat at the throttle?

MR. DEAN:—If heat is applied at the throttle, other conditions must be accounted for. That would involve the carbureter construction. If heat is applied at the throttle, the heat cannot well be prevented from reaching the jets and, by the time it reaches them and the float-chamber, it will increase the temperature, the area of the jets and the flow. The object is to get the heat to the point nearest to the point of maximum refrigeration without having any detrimental effects. That limits it to the throat, just above the throttle.

MR. HEGINBOTTOM:—Then it is equal to applying heat through a stove. If the jets are heated, the flow at the jets is increased, improving conditions so that the carbureter will operate properly sooner in warming-up. Regarding your remark about it being difficult to handle controlled heat, what is difficult about it and what troubles have developed?

MR. DEAN:—Some of the difficulties are practical ones and some are perhaps theoretical. When applied at wide-open throttle, the heat is entirely cut off. On a long climb, with wide-open throttle, the temperature in the manifold will drop to a point that will cause loading. At that time some heat is required and the heat is entirely shut off. Also, the added cost and the complication must be considered. Any butterfly-valve in the exhaust-pipe that is free enough to operate will permit leakage, which is objectionable for a closed car; and any one that is tight enough to prevent leakage will stick. The heat conditions there are difficult to control. We have secured satisfactory conditions with controlled heat. The point brought out is that we can get satisfactory conditions with the fixed-heat method without going to the expense and trouble of utilizing controlled heat.

MR. HEGINBOTTOM:—My experience with controlled heat is ideal. On a cold car, you can throw all the heat from the exhaust of the engine down through a riser and through the carbureter if you wish to. No heat escapes and it is all needed to warm the job up quickly, to heat the charges that leave the carbureter and aid vaporization. Also, it loosens up the flow through the jets so that the passage of gas through the jets is normal to the extent expected with the increased temperature under the hood. The hood temperature cannot be prevented from rising; so, the sooner the temperature of the jets can be raised to the temperature that is bound to be maintained eventually, the sooner the carbureter will function properly without an adjustment of the carbureter which will provide a surplus of gasoline.

C. H. TAYLOR:—Does the condition of the inside surface, rough or smooth, have any particular influence?

MR. DEAN:—The smoother the interior surface is, the better the action becomes. The cores for the manifold should be faced as smoothly as possible. We made some experimental manifolds of square tubing and brazed them together; that manifold had practically no liquid in it, because the liquid could not adhere to its smooth surface.

A MEMBER:—When Mr. Dean tested the engine with the three different types of manifold, was the velocity of the mixture increased or decreased?

MR. DEAN:—Our mixtures follow average practice very closely. We realize that the sharp turns we make in the manifold are necessarily somewhat of an obstruction. They do not permit as smooth a flow as do the round section and the long turns; but we are distributing fuel mixtures, not air. We can open-up those manifolds to compensate for such loss without having any detrimental effects. We make no claims of increasing the horsepower through use of this manifold; that is not our point. We state to its users that we can obtain other results that are to the advantage of the average driver. But we do not claim that we can increase the power over that of a wide-open manifold, by using the square manifold and the sharp turns. What we are after is to secure better starting from a cold condition, better fuel-economy and increased torque through the lower range. That shows up in acceleration; we can accomplish it without sacrificing top speed.

A MEMBER:—Mr. Dean mentioned two different firing-orders for a six-cylinder engine which gave alternate explosions on either side of the engine. Has he been able to detect any difference in the ability to distribute the fuel in those engines due to the difference in the firing order when using the three-port manifold?

MR. DEAN:—We have found no difference in our tests. So far as the manifold is concerned, the distribution is exactly the same. The fuel-mixture charges follow successive branches from the metering point; it makes no difference whether they take one or the other. In fact, if the first cylinder to fire was at the other end of the engine, the result would be the same.

C. S. PELTON:—Regarding uniform distribution of fuel, I would say that I have a six-cylinder car equipped with one of these manifolds and also with a carbureter in which it is possible to adjust the fuel mixture from the dash. After climbing a fairly long hill so that the engine was fairly warm, and while driving along a level street at a speed of about 25 m.p.h., I changed the carbureter adjustment to give a lean mixture. The engine cut-out in every cylinder, instantly, just as if the switch had been disconnected. The momentum of the car carried it on for several hundred feet; then I pulled the dash adjustment over to its normal position and each cylinder started to fire, without a single pop-back. Not the slightest evidence of any power impulses during the time that

the carbureter was leaned up below the firing mixture was apparent, showing that the distribution was nearly perfect.

O. C. BERRY:—I agree with Mr. Dean's remarks to the effect that one criterion of good manifolding is the amount of extra gasoline needed for acceleration. One carbureter with which I am familiar is constructed so that the metering of the mixture is entirely independent of extra gasoline for acceleration. In changing this carbureter from one engine to another, we find that the main change required usually is in the amount of accelerating gasoline. On a job having a long, cold manifold, particularly on one that has large volume, we have to put in great quantities of extra gasoline to get the acceleration; on other jobs we have to use very little extra fuel. My experience checks with Mr. Dean's exactly, in that the better manifold requires a comparatively small quantity of extra gasoline for acceleration.

To those who intend to experiment with manifolding, I would point out that the most direct way of checking the over-all results is to use a single-cylinder engine, as a basis of comparison. When the single-cylinder engine gives highest economy and the same carbureter adjustment gives the same result on the multi-cylinder engine under consideration, you have practically perfect distribution. Another test is that, if all the cylinders stop firing at the same time when the mixture is made lean, that is a very good indication of excellent distribution.

In designing an intake-manifold the two hardest and most important problems are to get an even distribution of the liquid fuel to the different cylinders and to get a proper application of heat. Several other considerations, however, should not be overlooked. The first of these is to get as small a wetted surface as is possible. Second, the minimum volume in the manifold that will provide the required air-flow is desired. Third, the minimum amount of delay for the liquid as it flows from the carbureter to the cylinders is requisite. Anything in the manifold design that causes any liquid to be delayed in its passage from the carbureter to the cylinder is a step in the wrong direction. These are the things that tend toward the development of a manifold that will require the smallest quantity of accelerating gasoline.

We have made recently a number of tests in our laboratory on an engine equipped with one of the Swan manifolds; it is a 2¼ x 4½-in. four-cylinder engine. We reached a fuel consumption at 1200 r.p.m. of 0.57 lb. of gasoline per b.hp-hr. That degree of economy was maintained from rather a low speed to rather a high speed. I attribute a large part of that excellent performance to very satisfactory operation of the engine, but I am also sure that it could not have been accomplished with poor manifolding. These tests were made with mixtures that were too lean and all the way up to a mixture that was too rich to operate. The cylinders all stopped firing at about the same time when the mixture became too lean. A point of carbureter adjustment was reached at which a cylinder would miss firing once in a while; then one more notch of carbureter adjustment put the engine out of commission.

R. F. KOHR:—In connection with the dropping out of all the cylinders at once, the value of that demonstration would depend largely upon the actual change in the carbureter adjustment that was made during this movement of the control. If this is a gradual change, all well and good, but if the control is in a running position and it is suddenly switched over to a too lean position, this means, it seems to me, nothing, because almost any adjustable

[1] See THE JOURNAL, February, 1924, p. 143.

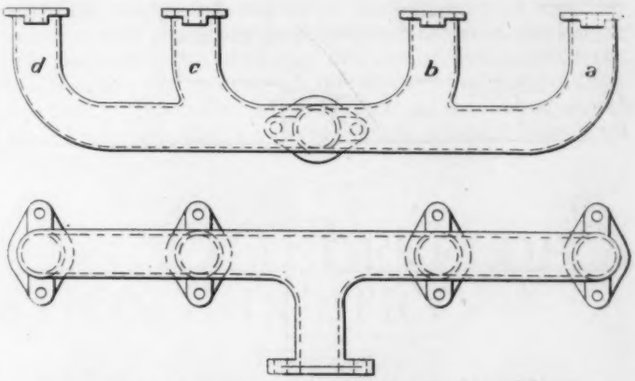


FIG. 2—A CONVENTIONAL FOUR-PORT SIX-CYLINDER MANIFOLD
In This Manifold the Flow Is First through the Branch *a*, Then through the Branch *c*, Next through the Branch *b* and Finally through the Rear Branch *d*

carbureter and any manifold will do the same thing. How much of an adjustment was that, from the running position to the full lean position? Without that information, the statement means nothing.

MR. DEAN:—Mr. Berry answered that question. They used as thin a mixture as they could get; then, when one cylinder began to miss, one more adjustment that thinned it slightly more caused all the cylinders to drop out. In the case mentioned by Mr. Pelton the adjustment has a total range of fuel mixtures; that is, from the leanest to the richest, with the dash adjustment that has nine divisions. That was one division.

O. M. BURKHARDT:—Our experience with a manifold that was of a different shape than round has been that upon removing the manifold we invariably found we could pour gasoline out of it. We did not find this to be the case with the round manifolds. The inference was that puddles had collected on the flat surfaces. These perhaps will make a square manifold a surface carbureter. However, the logical place to carburet is in the carbureter and not in the manifold.

The application of heat and the distribution of the mixture are not carburetion. If we want quick acceleration we must see to it that we get fuel to the cylinders quickly. Whether or not the presence of liquid fuel in the manifold will help to bring fuel to the cylinders quickly and in equal quantities, is problematical.

The manifold with which we are experimenting had four ports. What are the great objections to the four-port as compared with the three-port manifold for a six-cylinder engine?

MR. DEAN:—We always use the part marked *m* in Fig. 5 of the paper[1] as the distributing point that we may have a flow from this point always in a different direction. With a conventional four-port six-cylinder manifold as shown in Fig. 2 we would have a flow through the first branch at *a*, then through the third branch at *c*, next through the second branch at *b* and last through the rear branch at *d*. When a flow is established in any direction the heavier fuel particles tend to continue their travel in such direction until they reach some obstruction or are deflected. On the center branches you must draw from a stream that has a directional tendency to flow to the ends. You may be able to get equal quantities of fuel mixture but not equal qualities. We have obtained much heavier results with the three-port type where the metering is done at *m* in Fig. 5 and succeeding flows are always in different directions.

J. H. HOLLOWAY:—What effect is produced on distribution in reference to whether the axis of the car-

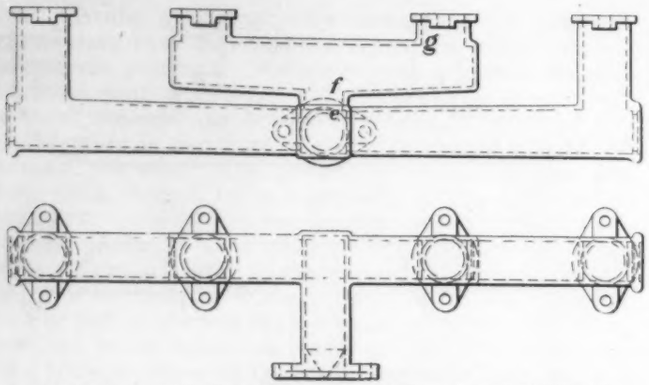


FIG. 3—A MANIFOLD DESIGN EMBODYING A SUB-MANIFOLD
In This Design the Fuel Mixture Makes a Turn at *e* from the Riser into the Throat of the Sub-Manifold, a Second at *f* from the Throat into the Runner of the Sub-Manifold and a Third at *g* from the Sub-Manifold into the Branch Leading to the Port. Only Two Turns Are Made in Reaching the End Branches as Compared with Three To Reach the Center Branches. The Resistance of the Center Branches Is Greater than That of the End Branches Unless the Areas Are Increased To Correspond with the Greater Resistance

bureter throttle is crosswise or lengthwise of the engine?

MR. DEAN:—The effect on four-cylinder engines of the two-port type is very decided, especially if the butterfly valve is close to the runner. On all our designs, we try to make the throat of the manifold long enough to overcome any effect of the throttle, and that is also the reason for our change from a round to a square manifold. We do get a serious deflection with the throttle. A throttle lengthwise of the engine is better.

A MEMBER:—Could one sraighten out that four-port manifold by taking three ports off the runner?

MR. DEAN:—It could be made with a sub-manifold as shown in Fig. 3, but that is not as good. In using the sub-manifold you get a turn at *e* from the riser into the throat of the sub-manifold, a second turn at *f* from the throat into the runner of the sub-manifold and a third turn at *g* from the sub-manifold into the branch to the port. You get three turns to the center branches as compared with two turns to the end branches. The resistance of the center branches is greater than that of the end branches unless the areas are increased corresponding to the increased resistance. When so proportioned the manifold works very well and is much better than the four-branch design shown in Fig. 2.

MR. TAYLOR:—How much advantage is derived from the squareness of the manifold and how much from the sharp corners and other characteristics of the Swan manifold?

J. W. SWAN:—The answer to Mr. Taylor's question is well covered in the subject matter of the paper. However, I might make it plainer by showing the difference in the action of the liquid portion of the mixture through a round as against a square section. The flow through the horizontal portions of the manifold is intermittent in our three-branch manifold, as shown by the firing order in Fig. 13 of the paper.[2] When the mixture is flowing to any one of the cylinders, the air and the gaseous portions of the mixture in the other two branches remain in a more or less static condition, but as the liquid portion is from 700 to 800 times heavier than the air the liquid in suspension in the air immediately falls to the bottom and that portion which is deposited on the wall drains down to the bottom. At low speeds, and consequently low velocities, this action is very pronounced.

Now in a *round* pipe *all* the liquid deposited on the walls drains down the walls and naturally forms a stream-line in the bottom of this pipe, while in a square pipe the liquid deposited on the walls has a different action, as that which adheres to the top or ceiling either remains there to be carried forward with the next inrush of air, or if it drops off it falls to the flat level bottom. As the top and the bottom in the square section constitute one-half of the inside surface, it is readily seen that the liquid will not stream-line but will spread out over the flat bottom that presents much greater surface for the liquid to come into contact with the air, thereby preventing stratification to a great extent. The sidewall drainage will also naturally spread out over the bottom. The virtue in the right-angle turns, and especially the turns from the vertical portion leading from the carbureter to the horizontal part, lies in the fact that the liquid particles in the mixture, due to their velocity and weight, cannot make a right-angle turn and are therefore carried up against the flat level ceiling from which they are swept into the branches, or failing to reach the ceiling are carried in the air stream somewhere between the right-angle turn and the ceiling and are not allowed to flow around the inside of an elbow and stream, especially if the elbow is of circular cross-section.

The right-angle turns at the ends of the horizontal branches are very similar in action to that at the center and prevent stratification and stream-lining, as in the case of the round-elbow type, thereby preventing flow to one cylinder in preference to the other at the entrance to the valve chamber.

Summing up, our object in this design is to distribute the *liquid particles* of the mixture to the cylinders in equal proportions, knowing that no serious difficulty will be encountered in distributing the air and the gaseous portion.

F. H. VOSE:—Mr. Dean has brought before us one all-important fact; namely, that an inlet-manifold must handle a mixture made up of air, dry vapor, wet vapor or fog and, at some engine speeds and conditions, relatively large particles of liquid gasoline. The designer of the type of manifold under discussion has recognized the above-mentioned fact and has aimed to design a device to deliver this mixture to the separate cylinders of an engine uniformly as to quality and quantity. Three outstanding characteristics of this manifold are: (*a*) its simplicity and entire absence of contraptions; (*b*) that the *character* of the path of flow to each cylinder is the same, being made up of straight lines and abrupt right-angle bends; and (*c*) that this manifold makes it equally certain for the mixture to reach all cylinders.

In my opinion, Mr. Dean placed too little emphasis on one other important item, namely, that the heavier portions of the mixture flowing through the manifold tend to travel in straight lines at above certain velocities. If a branch pipe to any cylinder is taken from the side of the main distributing-chamber, between the carbureter connection and the end of the main distributing-chamber, the heavier portions of the mixture tend to carry by this intermediate connection. The result is that the engine cylinder connected at this particular point does not receive its proper proportion of the heavier portions of the mixture. An examination of the various types of manifold illustrated demonstrates that they have avoided making any connection to the cylinders at points between the carbureter connection and the ends of the main distributing-chamber.

Some 15 years ago a certain three-cylinder two-cycle marine-engine was equipped with a horizontal manifold of circular cross-section curved at the ends of the main

[2] See THE JOURNAL, February, 1924, p. 147.

distributing-chamber to enter the ports of the end cylinders and had a side opening to communicate with the ports of the middle cylinder. The opening for the carbureter connection was directly opposite the branch connection to the middle cylinder. Even with the more volatile fuels of that day, this engine would never fire regularly on all three cylinders. Either the two end cylinders would fire regularly and the center cylinder miss or, with changing carbureter adjustment, the center cylinder would fire regularly and the end cylinders miss. Had I connected the carbureter to the main distributing-chamber of the manifold at the bottom instead of at the side, I am sure that all three cylinders would have fired regularly.

ADEQUATE LANDING-FIELDS WILL DEVELOP A COMMERCIAL-AVIATION INDUSTRY

BY A. A. G. FOKKER

MR. FOKKER describes the impressions of American aviation that he received on two previous visits to the United States and shows by contrasting them with the impressions he is receiving on this, his third, visit that great progress in commercial aviation has been made here in the last 3 years, especially with reference to the successful performance of the Air-Mail Service and to the fact that the general public and business men in particular have far greater confidence in its possibilities of development than formerly.

Giving instances where additional airplane routes are feasible even now in the United States and instancing the telegraph, the telephone and wireless transmission in proof that when an instrument or a way of communication is created which gives better and faster service it cannot be suppressed, Mr. Fokker gives an account of European aviation development, urges the necessity for attaining ability for aircraft to fly at night and specifies the advantages secured in Europe now by combined over-night railroad-and-airplane service. "Wild" or "taxi" airplane flying is described and spoken of as an imminent possibility and a classification of aerial transport is made that he believes will apply to the future development of the airplane. He asks "Why not more airplane flying?" and says aircraft terminals and facilities are requisite to this accomplishment.

In Europe landing-fields and facilities have furthered aviation development there and have brought increased business to the cities in or near which they are located. Specific citations of this are made, the effect of having adequate airplane facilities is enlarged upon and the provision of landing-fields throughout the United States is urged as a present necessity. Future aviation probabilities and the development of aerial traffic are also treated briefly. [Printed in the May, 1924, issue of THE JOURNAL.]

THE DISCUSSION

A MEMBER:—At present, air travel falls very much into the luxury class. To be of real advantage to the ordinary individual, it needs to be made cheaper and, to be a real factor in time-saving, aircraft must carry tons where they now carry hundreds of pounds. What is Mr. Fokker's idea of the development in types of airplane that can carry a very much heavier load?

A. A. G. FOKKER:—I can say that the cost of carrying freight through the air is not excessive. It is about 15 cents per ton-mile. But the trouble is that if I have only two ships flying a day, all the overhead expense is concentrated on these two ships, and that is 50 cents per ton-mile. But if you can have a field and can use all the facilities and have a great many airplanes, you can decrease the price so much that you come to a figure at which it is easy to get the freight at paying rates. Then you must never forget that you can charge much more for this aerial transportation. You can carry things much faster, and you can ask much more money. You pay much more for a telegram than for a letter to send just a few words quickly. Every business will be willing to pay perhaps 5 or 10 times more to have a letter delivered from New York City to Chicago in 10 or 20 hr. When you start an air-line you must start it in territory from which you are sure to get freight at increased rates. We shall never carry coal or similar commodities with airplanes, but only valuable things that have to be transported quickly and are not very heavy. If we only can get 1 per cent of all the express mail that is now carried by trains, we can carry it by airplanes at much less than the present price. Then we can establish an air-line with from 20 to 30 airplanes per day between Chicago and New York City.

A MEMBER:—What does Mr. Fokker consider the economic flying altitude?

MR. FOKKER:—With our present engines and airplanes we generally fly at an altitude not greater than a few hundred feet. We go up higher if we have to cross big rivers or lakes or mountains. If we have to cross mountain ranges of 5000 or 10,000-ft. altitude, we cannot use the same airplanes we use for ordinary flying. It will take considerable time to develop airplanes to fly at from 10,000 or 30,000-ft. levels. For the coming 10 years, I think we shall fly at low levels.

A MEMBER:—What is the average life of a commercial airplane?

MR. FOKKER:—That is a very difficult question to answer. During the war we built airplanes that were not used very long. They were either smashed in a very short time, or they became outofdate. During the last few years, however, we have been able to find out how long an airplane can live as determined by the life of its engine. I think that the life of an engine will be about 1500 to 2000 hr. I am sure we shall develop airplanes that can be used about 5000 hr. Our commercial airplanes that have been running 3 years on the lines are outofdate. We shall now rebuild them for freight carrying, because the cabins are not good enough for passengers, who are becoming accustomed to big cabins and adequate facilities. The present distance-life of an airplane is about 200,000 miles.

HELIUM GAS

A MEMBER:—A rumor is being circulated to the effect that helium gas for airship use has not been as successful as it was expected to be. Will Mr. Upson give us some information about that?

RALPH H. UPSON:—The helium-versus-hydrogen ques-

tion is, I think, a little too new to make it possible for any one individual to see the ultimate outcome or really to analyze the present situation perfectly. We here in Detroit have not been taking helium very seriously as a commercial product. Great doubt exists as to whether it can be produced plentifully enough, at enough different points, and cheaply enough to make it really suitable for commercial operation. Our principal line of development here has been to make the airship itself fireproof enough so that it can utilize any kind of gas.

Of course, it is a great addition to the safety of a fabric airship to operate it with helium, because helium itself is non-inflammable, and also will quench a fire that it covers. But it will never entirely eliminate the fire risk in a fabric-covered rigid airship like the Shenandoah. If you go inside the corridor of this helium-filled airship, you will find fire-extinguishers installed every few feet. Its officers are still very keen about fire protection and no relaxation of the fire rules has occurred, because it is perfectly possible for the fabric cover to burn away and with it enough of the inner gas-cell material to liberate all the gas.

No argument is present in anyone's mind against it being proper to use helium for airship inflation for flights not too distant from a base, but for the exploration of a great unknown region, the conditions are absolutely reversed. In the Arctic regions it would be far safer to inflate an airship with hydrogen and to operate it with hydrogen. The reason is that, with hydrogen inflation, the range of action of an airship under power is approximately double what it is when inflated with helium. Basing percentages on what a helium-inflated airship can do, a hydrogen-inflated airship can carry 40 per cent more fuel. Further, certain apparatus must be carried on a helium-inflated airship that is not needed aboard an airship inflated with hydrogen. There must be a heavy complicated ballasting system when helium is used so as to conserve the helium gas and not let it escape, as the airship gets lighter because of the consumption of the fuel. Hydrogen is so cheap that it can be allowed to escape if that is desirable. If an airship should make a long trip far distant from any base of supplies there would be need to use the hydrogen; it would be necessary to burn it in the engines. The fact that hydrogen is inflammable is one of the principal safeguards on a long trip such as that. So, for the small 7-per cent theoretical difference between helium effectiveness and hydrogen effectiveness that we thought we had at first, we have a 100-per cent difference.

The fire risk with a hydrogen-inflated airship is not nearly so great as many people believe. Of course, when a large airship does catch fire in the air and falls with all on board, there is a terrible disaster. Statistics show that ocean navigation is very much safer than railroad travel. It is much the same with airships. When an accident occurs, it is a bad one simply because it is a big unit, but the actual fire-risk as a percentage, even with the small amount of experience that has been had so far, is relatively small. For example, the airships on the Zeppelin lines have traveled close to 4,000,000 passenger-miles without a single casualty. Of course, that does not prove anything, but enough data exist for us to be certain that the danger from fire on a long trip in a hydrogen-inflated airship would certainly be less than 0.1 per cent.

Is it better to risk that 0.1 per cent of fire hazard and get 100-per cent extra safety in the matter of cruising radius by using hydrogen? It seems to me that the chances of going wrong on a long airship trip in the polar regions, of being caught in storms, blown off the course, losing the way, fogs, misconnecting with a landing crew, or of something going wrong with the steering-gear so that an airship would have to operate as a free balloon and need all its weight as ballast, are enough in favor of the use of hydrogen to far overbalance the slight fire-hazard that attends its use.

MR. FOKKER:—Making a safety comparison between airplanes and airships and referring to the figure of 4,000,000 passenger-miles without a casualty quoted by Mr. Upson for the Zeppelin airship lines, our airplane line has a flight record of 15,000,000 passenger-miles without a casualty. But another difference should be noted: the airplane line will operate every day on scheduled time, with 96 to 98 per cent of regularity. The airplanes have flown from London to Amsterdam when the boat service was suspended. But I am informed that, if a long trip with an airship is to be made, weather reports are secured from all over the country for 3 weeks before the flight is attempted. Of course, weather changes and a big gale might come; it will not be so easy then. I think that if an airship must stay up in the air 14 days and has fuel enough, it can ride over storms; but, up to the present, it is not possible for an airship to stay up that long if it has to carry a paying load. On a long trip such as has been referred to, all the load possible will be constituted of gasoline and will not be a paying load.

MR. UPSON:—Such as the recent transcontinental trip of a Fokker airplane! Naturally if a distance record is to be made, all the fuel possible is carried. As to navigating in a storm, I can hardly imagine an airplane duplicating the recent exploit of the Shenandoah. Starting a controversy as to airship versus airplane would be pointless, because it must be admitted that each will perform services that are wholly impossible for the other to perform. Thus their mutual relations are supplementary rather than competitive.

CHAIRMAN W. B. STOUT:—I am sure that no one here thinks that the steamship industry will put the railroads out of business, or vice versa. Each means of transportation has its field, and they are coordinated and work together. That will be true of the airship and the airplane as they develop. Without a doubt the heavier-than-air machine will develop more quickly, if only for financial reasons. More can be accomplished with $50,000 when dealing with airplanes than can be done with $500,000 and even much larger sums when dealing with airships. It costs vast sums of money to start in but, after the beginning has been made with lighter-than-air craft, we shall see some developments along the lines of economy and increased transportation facilities that will surprise us as much as the heavier-than-air machine developments surprise us now.

C. H. TAYLOR:—Has any combination of helium and hydrogen been worked out which will give the mixture the fireproof qualities of helium, still utilizing some of the greater lifting qualities of hydrogen and using the helium as a kind of fireproofer for the hydrogen?

MR. UPSON:—It has been found from experimental tests that we can add 15 per cent of hydrogen to helium and still have a mixture that is non-inflammable, but so far it has not been found worthwhile to do that because of various practical difficulties connected with repurification.

COMPARISON OF IDEAL AND COMMERCIAL CARBURETER-CHARACTERISTICS

BY C. S. KEGERREIS

SINCE previous papers by the author on this subject have dealt with the engine mixture-requirements at some length and these requirements are available to the public, only general information is included in the first part of this paper to illustrate the ideal carbureter-mixture requirements when using a fully developed acceleration device. In the second part, computed data illustrate the car carburetion-requirements of various cars for level-road operation. The car-test data were procured from various sources and combined with research results obtained in the Engineering Experiment Station of Purdue University to delineate the factors desired. The results show the information regarding the advisability of using straight-line mixtures.

The third part constitutes the main section of the paper, and especial attention is called to it. Data are presented on commercial carbureters, the results of several devices are shown in detail, and a summary of the 23 carbureters tested is included for the general conclusions. The test results consist of information on the effect of pulsations, on metering characteristics, on frictional loss across carbureter bodies and on the effect of air temperatures on metering. Using the methods of computation by which the data in the second part of the paper were determined, the results are expressed in terms of ideal mileage per gallon of fuel for various cars that are assembled into four classes. Using the same methods, the carbureter results were computed to show the economy any one device would effect in car operation and, in the fourth part of the paper, 11 devices are thus compared with the ideal carbureter at various car speeds. [Printed in the March, 1924, issue of THE JOURNAL.]

THE DISCUSSION

R. F. KOHR:—Please describe the different kinds of carbureter that were used.

C. S. KEGERREIS:—Three general types were used. The plain-tube type has no moving parts. The constant-vacuum type has an air-valve; the fuel-metering pin is carried on the air-valve and dependence is placed on the vacuum in the carbureter body to change the air area and the fuel-pin area. This tends to cause the body vacuum to remain constant; hence its name. The fuel-air-proportioning type is slightly different; usually a linkage connects the metering-pin and the air-valve. The latter is actuated by the carbureter-body vacuum, which may vary according to each design.

The constant-vacuum and the fuel-air-proportioning types are so similar that they are classed as one type. The third type discussed was listed as a compensated auxiliary air-valve. The air-valve in this type is not mechanically connected to the fuel-metering pin or the orifice. The flow from the fuel nozzle is governed in various ways to compensate or satisfy each individual design.

O. C. BERRY:—Laboratory tests bring out many valuable points in carbureter design. The carbureter engineer may, however, be entirely familiar with these points and still not be able to incorporate them into the carbureter he sells. He must give the automotive engineer what he wants, whether it be the right thing or not. The automotive engineer wants what he thinks the consumer will buy, whether it is right or not. The buyer of an automobile should have the points in Mr. Kegerreis's paper thoroughly in mind when he passes upon the carbureter that is on the car he buys.

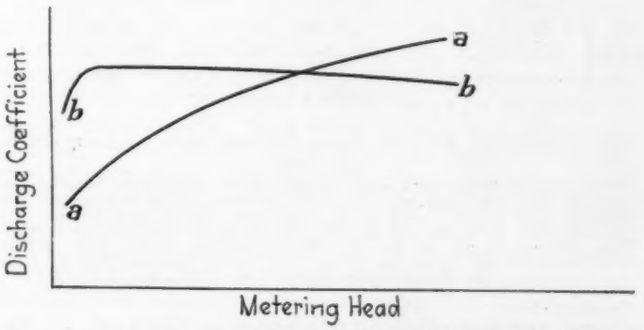


FIG. 4—RELATION BETWEEN THE DISCHARGE COEFFICIENT AND THE METERING HEAD OF CARBURETERS

The Curve *aa* Indicates the Relation for a Commercial Unit, While the Curve *bb* Was Obtained with a Short Sharp-Edged Orifice. In the Latter Case the Metering Was Stable with Respect to the Temperature

The fact that the carbureter engineer must please the automotive engineer is responsible for many of the characteristics of present carbureters. The average driver does not care at all for economy at low speed. What he wants there is positive action; a carbureter that does not give positive action at low speeds is a failure. For medium speeds, sometimes the automotive engineer gives considerable attention to economy, but at top speed the car must be just as fast as some other or the carbureter is condemned. Carbureters are very fine metering instruments in spite of the rather poor showing they have made on Mr. Kegerreis's charts. It seems to me that the offender is not the carbureter but the manifold.

P. S. TICE:—Mr. Kegerreis proves to us that to get good performance the mixture-proportion variation in the carbureter must be as shown in Fig. 5 of his paper.[1] The variation must be with the load and it must be after the fashion shown. But Mr. Kegerreis said nothing about how the rises or the enrichment effects are caused in the metering. In most carbureters, they are due largely to variations in the coefficient of discharge of the nozzle, which quantity changes with the temperature. For nearly 6 months I have been trying to develop a nozzle form that would eliminate temperature effects; that is, give a zero temperature-coefficient. If we follow the metering head on the nozzle, in any commercial unit you like, we get a curve of the general form shown at *aa* in Fig. 4.

Most carbureters have submerged nozzles, and they are neither short nor sharp-edged. With a change in head we get, normally, a coefficient change of the sort indicated in Fig. 4. At the low speeds, throttled, we have a very small metering-head, but with wide-open throttle we have a somewhat greater metering-head. At the high speeds and small load we may have something in between; and at very high speed and load we have the maximum values. Ordinarily a wide change of coefficient

[1] See THE JOURNAL, March, 1924, p. 289.

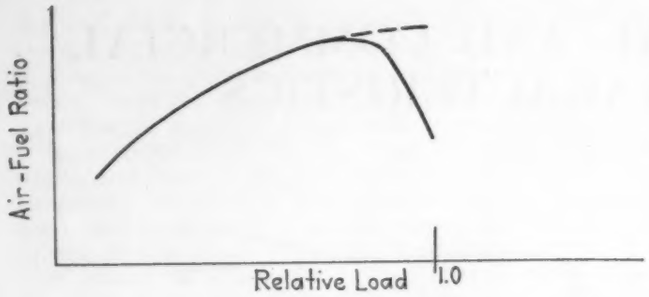


FIG. 5—HOW THE AIR-FUEL RATIO CHANGES WITH AN INCREASE IN THE LOAD

The Optimum Metering Characteristics in a Carbureter Will Maintain the Minimum-Consumption Mixture-Production throughout the Greater Part of the Load Range and Will Enrich the Mixture To Cause Maximum Power Delivery as Full Load Is Closely Approached. This Change Is Shown by the Portion of the Curve That Turns Downward at the Full-Load End. The Curve without This Change Is Represented by the Dotted Line

occurs, and regardless of the speed or the load, as the flow of air to the carbureter is increased we get relatively more fuel.

If the temperature is constant that variation of the coefficient with the head can be utilized. Most of the carbureters that are in service today do have such a general variation of the coefficient with the head, and they operate successfully because the rest of the carbureter is built to give at least an approach to the sort of metering desired, even with or through direct utilization of this variation in the coefficient.

When we apply a change of temperature of appreciable value, to the fuel that is passing through this nozzle, the coefficient is altered; if we raise the temperature we raise the coefficient. We can raise it very appreciably. Mr. Kegerreis has shown that it is about 15 per cent for 100 deg. fahr. That is very undesirable. It is the chief thing that is preventing us from getting away from mixture adjustment in the carbureters of today. The difficulty is not an error in metering per se but this change in the fuel discharge with a change in the temperature. Very few carbureters are designed to permit putting in a short sharp-edged orifice that gives the sort of coefficient curve shown at *bb* in Fig. 4, indicating stable metering with respect to the temperature, without completely re-designing the rest of the instrument. In our carbureter, we desire to have not exactly the shape of metering curve shown in Fig. 5 of Mr. Kegerreis's paper, but we do want something like the curve *aa* of Fig. 4 for

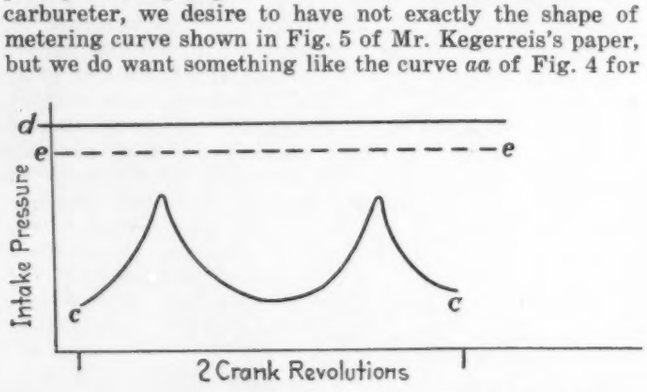


FIG. 6—CYCLE OF INTAKE PRESSURE WITH THE THROTTLE WELL CLOSED

The Curve *cc* Shows the Relative Variation in the Intake Pressure through Two Revolutions of the Crank, the Atmospheric Pressure Being Indicated by the Line *dd*. As the Throttle Is Opened the Curve *cc* Rises until Its Mean Reaches a Valve Corresponding to the Dotted Line *ee*. In Some Positions of the Throttle the Peaks of the Curve *cc* Come above the Atmospheric Line. When That Happens the Metering Departs from the Computed Curve and the Farther the Peaks Rise above the Atmospheric Line and the Longer They Remain There, the Greater Is the Enrichment

our coefficient curve; and we know how to get it by a suitable selection of nozzle form. Recently, we have directed much of our work toward getting rid of this variation resulting from temperature changes. Now, we retain any one of the desired general shapes of coefficient curve, as *aa* in Fig. 4, and can have the temperature vary from 0 to 56 deg. cent. (32 to 132.8 deg. fahr.), the latter being the highest temperature we regularly run, with only a 2-per cent change in the coefficient due to this temperature variation. We have done that in an interesting way by putting short orifices in series. One can put as many orifices as desired in series and get a greater and greater slope in the coefficient curve, with an increase in the number of orifices, still retaining this approach to the zero-temperature coefficient.

A MEMBER:—What is the amount of difference through the normal range?

MR. TICE:—We have ignored that and gone right at the net effect at the nozzle.

A MEMBER:—Are specific figures available as to the flow rate per given nozzle?

MR. TICE:—None of us is interested in absolute values of the discharge, but only in relative values; that is, in the coefficient changes. The orifice size does not, within the limits useful in a carbureter, appreciably affect the range of the coefficient with a given change in the head. Within the range of size that we can use, changing the size has very little to do with it.

Mr. Kegerreis mentioned results with and without pulsations. With the form of carbureter that we have been developing, if we get the air-flow through the carbureter as steady as is possible in an engine installation without going to extreme lengths, we get a metering characteristic such as would be computed for this carbureter with change of load while the speed is being held constant. Really steady-flow results check these engine results perfectly. Applying the carbureter to a four-cylinder engine in which the pulsations are considerable, gave us a curve that, except for the enrichment when approaching the open-throttle position, was also almost exactly the curve computed. This enrichment of the mixture from around 0.8 load and up was solely due to pulsation, as to the manner in which the flow and the pressure pulsations acted on the fuel passage in the carbureter. This led to an attempt to determine the cause. We think we have determined it to be purely a matter of the change in the relative velocity and in the back-flow through the carbureter. Opening the throttle we follow the computed curve until we get to a point in the load range at which the pressure in the manifold is becoming more nearly atmospheric. The back-flow from the combustion space to the intake is changing in its relative magnitude, and then we begin to get the effect shown in Fig. 5. The cycle of intake pressure with the throttle well closed is shown by the curve *cc* in Fig. 6. Atmospheric pressure is indicated at *dd*. As we open the throttle, the curve *cc* rises until its mean reaches a point as *ee*. In some positions of the throttle the peaks of *cc* come above the atmospheric line. When that happens the metering departs from the computed curve. The farther the peaks go above the atmospheric line and the longer they last, the greater the enrichment is.

If we use a carbureter that has been completely worked out for use on a four-cylinder engine and apply it to a three-cylinder engine, for example, to three cylinders on a Liberty-12 engine, we get an extreme exaggeration of this effect. It is a result of two things: First, the greater duration of this high-peak condition with the three-cylinder engine and the fact that the pulsation fre-

quency is lower; second, we have in the Liberty-12, compared with the average car-engine, a large reduction in the manifold volume in comparison with combustion-space volume. This means that the velocity of the back-flow into the intake is very much greater and gives a greater variation in the pressure. The pressure at open throttle goes well above the atmospheric pressure in that case, and we get much greater enrichment.

MR. KEGERREIS:—In Fig. 11 of my paper, the black dots represent wide-open throttle conditions on the engine. The engine ran at speeds varying from 600 to 1000 r.p.m. We had a thin metal box around the carbureter and the box started pulsating or vibrating. We had a pulsating flow upon the throttle at that point as well as on the carbureter intake. When the carbureter nozzle is put in the manifold, which is the same condition with the box vibrating, I think the pulsations will cause that enrichment. Otherwise, with the throttle in its normal position and the box not vibrating, you do not get that condition on wide-open throttle with the carbureters we have run; because, with the same arrangement in some of the other graphs shown in my paper, we have had wide-open throttle and no change in the metering results could be noticed.

C. F. SCOTT:—Does Mr. Kegerreis advocate a manual adjustment of the needle-valve from the dashboard?

MR. KEGERREIS:—Opinions on that subject vary. At first thought, I would say "no." With the average design, wear may occur there in time, so that the needle-valve will perhaps move or the carbureter get out of adjustment. Another thing with which I am not satisfied entirely is that, if the needle is not concentric with the axis of the orifice, it is not clear whether there will be the same metering.

Some tests were made by A. C. Fieldner and G. W. Jones, of the Pittsburgh Experiment Station of the Bureau of Mines, on some Government trucks. The results of these tests were published under the title of Gasoline Saved on Government Trucks by Adjusting Carbureters by Exhaust Analysis. Most of the carbureters on these trucks are adjustable and their results show that they were not able to maintain the same economy as that given by the original adjustment. Those tests were run for a period of 3 months.

However, a dash adjustment for starting is necessary. The stringent use of a butterfly choke, is, I think, too hard on the engine; it wastes too much fuel and no accurate means of adjustment for warming is provided.

Considering the means provided for the starting enrichment, after getting the engine warm some means of taking care of normal operation must be supplied. For one of the tests I have described, the 35 to 40-per cent change of mixture shown causes loss in economy, unless the carbureter is adjusted from the dash. Some sort of thermostatic control ought to be devised so that, as the engine warms, the device will automatically reduce the mixture to the right proportions.

It is expected that test data will appear in bulletin form, issued by Purdue University, that will cover 23 carbureters in detail, three temperature runs having been made with each carbureter. The report will show in detail the test results at normal temperatures; at about 70, 125 and 175 deg. fahr.

C. W. MCKINLEY:—We made some tests of a fixed-jet type of carbureter on an engine to show the effect of spark control at a given engine-speed and also that of the water temperature. Certain engines gave some trouble on account of spark knock, and it was desired to know the effect of a change of spark-advance. We found that some drivers had been driving with the spark set back to about a 5-deg. advance to get rid of the spark knock. Running with the spark advanced 5 deg. that engine required 1.5 lb. of fuel per b.hp-hr. under a given temperature condition. With the same temperature condition, and the spark advanced 35 deg. the same engine required 1.1 lb. of fuel per b.hp-hr.

A point to keep in mind about high-compression engines is that the driver's use of the spark to get rid of knocking must be taken into account; it will be very detrimental to the fuel economy if he drives at a degree of spark-advance at which he does not get a spark knock during acceleration. The water-temperature effect was also very interesting. No change was made on the carbureter and, at the most economical spark-advance, which occurred at 35 deg., where we secured the maximum economy of 1.1 lb. of fuel per b.hp-hr., the change in water temperature from 212 deg. fahr. was to between 82 and 100 deg. fahr. At a 35-deg. spark-advance and an 85-deg. fahr. water-temperature, the fuel consumption was about 1.32 lb. per b.hp-hr.; so, there was a 20-per cent variation due to the water temperature alone, with no change in the engine or any change in the carbureter. Hence, the total effect of the spark-advance and the water temperature amounts to more than a 50-per cent difference in fuel economy. Other things than the manifold and the carbureter must be taken into account.

F. E. MOSKOVICS:—An important factor is the temperature condition under the hood. As an illustration, a certain automobile performed very well normally, but it gave trouble under high-speed conditions. Finally, the car was driven to the "Hill" at Uniontown, Pa. The inlet-air temperature was about 140 deg. fahr. and the car ran fairly well during the trip. On the first trip up the Uniontown hill, the car barely got to the watering trough about two-thirds of the distance up on high gear and did everything that an automobile should not do, knocking, steaming and boiling; then the transmission was used and the car got to the top of the hill. The same thing was tried again under similar conditions except that the air was taken from the outside. The temperature then rose to a mean of not more than 130 deg. fahr. and the car went to the top of the hill without any knocking on high gear. The same characteristics were exhibited by four other automobiles. They would knock when going up long hills but, after putting on a horn to take air from outside the hood, the same automobiles could climb such hills without knocking, or over-heating.

MR. BERRY:—Did you note whether the temperature of the gasoline was high enough in the jet of the carbureter to boil the fuel and, consequently, cause the mixture to be lean under those high-temperature conditions?

MR. MOSKOVICS:—The only change made was to draw the air from the outside.

MR. MCKINLEY:—I believe that a large part of the trouble just described was due to boiling. On similar tests, after stopping the car and taking the cover off the float-chamber, one could see the bubbles coming up through the gasoline. The actual temperature of the gasoline is very close to 200 deg. fahr.; under that condition, boiling in the carbureter certainly must occur.

MR. KEGERREIS:—It has been determined that a temperature of about 84 deg. fahr. gives the maximum power; any higher temperature tends to reduce the power somewhat.

F. C. MOCK:—The condition that Mr. Moskovics mentions is met more often than most of us realize. Frequently, when in cold weather, we heat the charge to make the engine operate as it should, we find in warm

weather that the engine has lost considerable power on hills. Although that loss of power is usually ascribed to a loss of volumetric efficiency, in almost all cases it is due chiefly to detonation. Just now I regard this matter of detonation as the practical limitation of the amount of heat that may be used, rather than any power-loss due to decreased volumetric efficiency, which is usually very slight as regards its effect on car performance.

PROCESS OF AND EQUIPMENT FOR FENDER AND BODY ENAMELING

BY GORDON LEFEBVRE

RECENT improvements in the mechanical equipment and the processes employed in the various car-assembling plants of a large motor-car building company are described, as a result of which these departments have been transformed from the most unsightly parts of the factory building into the cleanest, most comfortable and least dangerous. The processes to which special attention is devoted are those for the enameling of fenders and sheet-metal parts and such small parts as various stampings, forgings and malleables and cover the application of two coats of an asphaltic-base enamel and a subsequent baking at about 450 deg. fahr.; in body enameling they cover the application of three coats of similar material and baking at from 290 to 350 deg. fahr.

The course of the various parts is followed from the time of their receipt to that of their delivery to the assembling department to which they belong. When first received from the stamping department or from outside sources they are carefully inspected. They are protected from rust at the source with an outside coating that may be easily removed later by a washing process that precedes enameling. Successive improvements in the fender-enameling ovens consisted of replacing the original box-type ovens, which were open at one end and in which the dipping was done by hand, with those of the semi-continuous type, open at both ends and arranged in line in such a manner that certain parts could be dipped and hung on the conveyor bars while other parts previously dipped and run into the ovens were baking; these ovens in turn were superseded by those of the continuous type in which the parts are hung on the conveyors at one end, are automatically dipped, allowed to drip and baked and not handled again until they finally emerge at the discharge end completely finished with a double coating of enamel. The body-enameling ovens likewise were changed from the original square-box type with doors in the front to the tunnel-type equipped with power conveyors. The last three batteries built by the company were further improved by being suspended overhead with the ends inclined to the floor, thereby forming a seal at each end and completely trapping the oven.

The ideal oven-wall should have low thermal-conductivity, low thermal-capacity and the minimum amount of through metal, should contain the minimum amount of metallic materials, form a rugged construction, be designed, if possible, to allow the ready removal of the oven without waste of material, provide a smooth inner surface to facilitate cleaning, be completely dust-tight and non-dusting and have a reasonably low first cost of construction. The ideal conveyor should carry the body through all three coats without the necessity for removing it from the conveyor after each bake and mounting it again to flow-on the succeeding coat; but with large production this would require an unreasonably long building.

A system of handling enamel is described that ensures absolute cleanliness and safety, prevents waste and provides centralized and economical operation.

Indirect gas heaters were superseded by electric heaters so that electric heating became standard throughout, with the exception of one bank of body ovens in which electric heaters were used in the central zone to supplement high-pressure steam-coils. Electric heating was satisfactory so far as ease of operation and accuracy of control was concerned, but was found to be costly and the cause of numerous fires in the ovens. As a result the electric heaters have been discarded in favor of indirect oil-fired hot-air heaters, each oven having its own individual heater of the multiple-unit type. Compared with electric heaters, the first cost of the equipment is favorable, the cost of maintenance is negligible, the labor operation cost about the same and the fuel cost per unit much less.

In addition to arrangements for automatically emptying the tanks in case of fire, the dip-tanks and drainboards are protected with automatic Foamite extinguisher heads and the fender ovens are equipped with open-end high-pressure steam lines for smothering the fire with steam. Body-oven flow-rooms are protected by water-sprinkler heads.

Special attention is devoted to cleanliness, not only of the materials but of the equipment, tanks, conveyors, floors and the like. A ventilation system injects washed air into the rooms, which creates a static pressure and a flow of air current outward through the doors and the windows. This prevents dust-laden air from entering.

Distribution of the finisheed enameled parts to the various assembling departments is done by overhead conveyors that reduce the labor cost of handling, minimize the rejections on account of injury, occupy less floor space and at the same time provide means of carrying a small stock of finished parts ahead of the assembling operations. [Printed in the February, 1924, issue of THE JOURNAL.]

THE DISCUSSION

JOHN MCGEORGE:—One thing that I should like to emphasize is the necessity for getting into close touch with the steel makers. I know from experience that the steel needs close watching and inspection at all stages of manufacture. I have not yet seen in any automobile establishment what I should consider sufficient inspection and testing of steel sheets. In the drawing and similar processes that enter into all parts of sheet-metal work in automobile construction internal strains are induced that seriously affect the surfaces. Some defects that result from these strains do not show on the surface when the steel is received but become evident in the drawing and similar operations because of the lack of homogeneity of the metal. Much care must be taken in the inspection of the sheets and in determining what ones are suitable for drawing and bending purposes. The want of homogeneity of the metal will be made apparent every time by the heat, under the surface of the enamel or whatever you are using. Sometimes the trouble is very obscure and you do not know what causes it.

I should like to indorse everything that has been said with regard to cleanliness. Cleanliness is at the bottom

of all enamel work. If you do not keep the surfaces perfectly clean you will have trouble before you get through. The rejections will be many.

I was pleased to know that the old plenum system of ventilation is being used to keep out dust. I think that is a great improvement.

Another point I noticed in the paper is with regard to the pulsating of the chains through the ovens. This should have more study. I know of some of the troubles that Chevrolet has had, particularly in one plant, to get that pulsation out of the chain. I had the same difficulty. At first it seemed as if we should never get it out. It suddenly disappeared one morning and the chain has been running since as steadily as any chain possibly could run. It is a matter of dispute as to just what did take out the pulsation. The speeding of the chain, the way the chain is led over the sprockets, the diameter of the sprockets, the difference between the diameters over the teeth and over the flat side of the sprockets, the angle at which the teeth leave the sprockets, all these come in, and they have not been sufficiently studied by the conveyor builders or the designers. There is room for considerable study on all these points and if any of you are troubled with pulsating chains, you will find it worthwhile to go right through from the beginning. You can no doubt find the trouble. I know you will not stop until you succeed in getting a fairly steady chain. I was talking to one of the designers of a conveyor-building company only about 3 weeks ago. I had some ideas that did and some that did not coincide with his. I said to him, "I know of two chains of your manufacture running side by side. These chains are exactly alike, so far as you know, are they not?" He said, "They are supposed to be exactly alike all the way through. Pains were taken to take the pulsation out of them." I asked him, "Are they running alike?" He said, "No. One is running just about as well as could be expected. The other is not good at all, yet they are supposed to be exactly alike."

A MEMBER:—Is the quality of the enamel controlled by gravity? Has any attempt been made to follow viscosity in controlling the enamel and causing it to flow properly?

GORDON LEFEBVRE:—Three factors enter into the control of enamel: viscosity, specific gravity and temperature. We attempt to control all three.

A MEMBER:—Do you find that specific gravity has anything to do with the ability to flow?

MR. LEFEBVRE:—Yes.

A MEMBER:—Our experience has been exactly the opposite. In sampling incoming shipments of the material we find that they vary as much as 50 per cent in viscosity and sometimes 100 per cent, depending upon the method by which the supplier controls the product. The material, even though it vary in viscosity, may have uniform specific gravity. Then if it is reduced to a certain specific gravity that we have been using, we find that the viscosity will be entirely different and that, consequently, the results we get are very different. Accordingly, we control our production entirely by viscosity.

MR. LEFEBVRE:—That is very interesting. I did not want to get into a discussion of these technical aspects. I am not an enamel expert. We have always attempted to control the viscosity, the specific gravity and the temperature. The viscosity is controlled indirectly. We have found that with any given material the viscosity will remain uniform provided the temperature and the specific gravity are held constant.

A MEMBER:—In baking enamel at 300 deg. fahr. with wood frames in the body, what are the results?

MR. LEFEBVRE:—At present the wood-frame bodies remain in all our body-ovens slightly more than 1 hr. at 300 deg. fahr. There is no ill effect on the wood or the glue.

A MEMBER:—Does that wood have any preliminary treatment before it enters the oven?

MR. LEFEBVRE:—It is slushed before it is put into the oven.

A MEMBER:—Do you find that you can clarify the primer-enamel or so-called rubber?

MR. LEFEBVRE:—As I stated in my paper, we never attempt to do that. It removes the body from the enamel. We keep the enamel clean by straining it, running it through gravity strainers on the way to the dip-tanks in the morning and back through strainers on the way to the storage-tanks at night.

EUGENE BOUTON:—What experience have you had with enameling gasoline tanks?

MR. LEFEBVRE:—We enamel them, but not with this equipment. We have a separate oven for that purpose because it is a soldered job and we have to maintain a lower temperature.

MR. BOUTON:—What is that temperature?

MR. LEFEBVRE:—Approximately 275 deg. fahr.

MR. BOUTON:—That would necessarily take a longer bake, would it not?

MR. LEFEBVRE:—Yes, we bake the tanks for 2 hr. at that temperature.

QUESTION:—Do the products of combustion of the oil-burning heater enter the oven?

MR. LEFEBVRE:—No. That is explained in the paper. The products of combustion pass through the interior of the cast-iron sections, from the bottom to the top, and out through a stack, while the air used for heating passes around the cast-iron sections from the top to the bottom.

QUESTION:—What do you consider the best method of cleaning metals for enamel and paint?

MR. LEFEBVRE:—The method we are using is washing the metal with a preparation called Oakite, or OPC, which stands for Oakite Platers Cleaner. The metal is subsequently rinsed and dried in an oven to remove or get rid of the water, and is then wiped. We consider this the best method for large-volume production.

QUESTION:—What temperature is used for wood-frame bodies, and for fenders?

MR. LEFEVBRE:—For fenders, 350 deg. fahr.; for bodies, between 300 and 320 deg. fahr. We found that it is possible with this high heating equipment to increase the temperature slightly to as high as 320 deg. fahr. and to speed up the baking without injuring the woodwork or the glue.

QUESTION:—How do you clarify enamels?

MR. LEFEVBRE:—The finishing coats for the bodies and the fenders are run through standard clarifying machines. The rubber coat is clarified as explained before. The clarifying machines are like cream separators.

QUESTION:—What temperatures of water and air do you use at the washing-point?

MR. LEFEBVRE:—The water is heated to between 190 and 200 deg. fahr. The air is ordinary high-pressure air from the compressor; no attempt is made to heat it.

QUESTION:—How did you overcome the tendency to condense in the entering zone of the body ovens?

MR. LEFEBVRE:—We tried several different things. We finally overcame the tendency to condense at the work-entering end of the body-ovens, which is a place where we had trouble, by installing false ceilings. We do not advocate this method, however, because we know that the cause of condensation is poor ventilation; but, not hav-

ing time to whip the problem into the proper shape, we installed false ceilings.

QUESTION:—What materials are used to slush the woodwork of the bodies?

MR. LEFEBVRE:—I cannot tell the exact composition of the material we now use. It is a standard preparation bought from a paint and varnish company. I think it adds to it the wastage and the dirty enamel from other operations in the plant. Everybody uses a different preparation.

QUESTION:—By what metohd is the proper hardness of the finished enameled or painted surface determined by the inspector?

MR. LEFEBVRE:—The methods used for determining the hardness of the finished product are very crude. The one most in vogue is the finger-nail method. If you cannot scratch the finish or make an impression on it with the finger-nail, the enamel is considered to be hard enough. If everything is running smoothly, and the temperature and the conveyor speed, both of which are easy to control, are right, there is no necessity for inspecting the enamel for hardness.

CHAIRMAN JOHN YOUNGER:—Many pretty good old-fashioned engineers still believe in the file for testing case-hardened or tempered surfaces, so I think the finger-nail method is a good one.

QUESTION:—How long are the small forgings that have been enameled held at the maximum heat?

MR. LEFEBVRE:—All the small parts, the stampings and the malleables are put through the fender-enameling process. They are usually mixed in with the fenders, occupying those portions of the bars that the fenders do not occupy. They get exactly the same temperature, which is 450 deg. fahr., and length of bake, approximately 25 min., as the sheet gets.

QUESTION:—Do you have a method of regulating the speed of the conveyor?

MR. LEFEBVRE:—Yes. All conveyors are equipped with variable-speed motors connected with the head-shaft through a spur-gear reducer and are controlled by rheostats.

E. W. WEAVER:—What pickle solution do you recommend? What is the best neutralizer for the acid solution? We have been using muriatic acid.

MR. LEFEBVRE:—We have had no trouble. We never pickle our sheet metal at all.

QUESTION:—What can you do with water containing iron?

MR. LEFEBVRE:—We have had only one experience with water trouble in our washing machines; at Norwood, Ohio. We eliminated it by getting water from Cincinnati.

QUESTION:—What is the best fender coating to prevent rusting of rough-stock storage?

MR. LEFEBVRE:—As I said in the first part of my paper, I think this is a problem that should be worked out by each individual company. I think that no one protective coating will meet the needs of all plants. You must have some sort of protective coating that is easily removable in the washing operation preliminary to enameling. It should tie-in properly with the washing compound that is used.

SOME SUGGESTIONS FOR BUILDERS AND USERS OF MACHINE TOOLS

BY THOMAS NADIN

MANY machine-tools suffer from insufficient lubrication, both as regards the machine itself and in the means provided for lubricating the cutting tool. For slow-speed intermittent work it is satisfactory to lubricate a bearing through a small hole in the boss in which the shaft revolves; but this is not suitable for bearings of machines running constantly at medium speed. In stationary bearings a remedy is to be found in the use of a felt pad of liberal size on the under side of the bearing, kept in contact with it by a spring and properly protected from dirt. A better construction is the type of self-oiling bearing commonly used on electric motors and lineshafts, or better still a ball or roller bearing. Loose pulleys and similar bearings require roller bearings for slow and medium speeds, or single-row ball-bearings for higher speeds. These must be carefully designed for use with heavy mineral oil rather than cup grease.

Systems for supplying lubricant to the tool, although usually provided with pumps of sufficient size, frequently have guards and channels that are insufficient to take care of the splash and the return and a microscopic filter that soon becomes choked. On automatic machines these are sometimes found to be unusable after 2 weeks' service. This results in the spindle bearings, the slides and the screws becoming worn because of the presence of solid matter in the cutting oil. Tanks frequently serve as a storage space for chips. To obviate this, the tank should have two compartments, the first acting as a settling tank, from which the compound should flow over a weir into the second tank, in which the pump suction and the filter are located. The tank should be deep, be kept free from chips and swarf, have well sloped trays and channels and a filter of substantial construction of approximately 1 sq. ft. of filtering area well protected with gauze and should be easily accessible and removable. Flexible metallic hose is preferable to rubber, which becomes soft and useless after a short time. Defects could easily be overcome by the builders if purchasers and users would insist on having machines in which the troubles described are absent. [Printed in the February, 1924, issue of THE JOURNAL.]

THE DISCUSSION

CHAIRMAN K. L. HERRMANN:—I think Mr. Nadin need not apologize for bringing up a subject of this kind. Every one of us recognizes that the details he has brought out are very common in connection with motor-car building machinery. It seems rather odd that at this late date we should have to talk about such a thing as an oil-hole being plugged up with a piece of iron that sooner or later falls out, the machine then receiving instead of oil, dirt and chips from the machine. But 50 per cent of the machines we buy today are of that type. We shall do considerable good if we show the machine-tool builders that we cannot use this kind of machine any longer. We could not sell the public a motor car built on that basis, yet we who are supposed to be mechanics buy machine-tools daily that are built in that way.

W. W. NICHOLS:—I was very much surprised at and interested in what Mr. Nadin said about his countershaft troubles. I have experienced many of them myself, but I found considerable relief in the use of wood bushings, oilless bushings with a collar on each side. These last

a long time, much longer than a bronze bushing, under ordinary service conditions.

The other day a new vacuum oil-cup was brought to my attention. I think it is one of the cleverest things I ever saw. The sample shown to me was a metallic cup, filled with water; if you hold it in your hand for less than ½-min., the cup will begin to drip. That is getting people out of considerable trouble that they have had with regular oil-cups, because the feed will start only according to the heat of the bearing. It reduces the flooding of the bearings and making the machine look like a slop can.

J. N. HEALD:—The designers of machine-tools have made great strides in recent years in self-contained machines, by doing away with countershafts. You can see that in the single-pulley-drive milling-machines, in self-contained grinding-machines, radial drilling-machines and in machines of other types.

The probability is that one of these days very few shops will contain machines that are driven from overhead countershafts. I was in a factory recently where in a room of excellent modern mill-type construction one section contained 20 grinding-machines with overhead countershafts. In another section with an intervening space of 50 ft. was another group of grinding-machines, all of which were motor-driven. The contrast in lighting was marvelous. Where the grinding-machines were installed with overhead countershafts the artificial illumination was turned on full, as it would be at night, and the men were working practically by electric light. In the other section, on work that was equally intricate, not a single electric light was in operation. Daylight was adequate in that section, which was in the same room with the first group of machines. One set of machines was grinding the curve in a ball race, and the others were grinding the straight hole inside the same race. The character of the work was obviously similar.

The removal of overhead countershafts and belting would be a great boon to cleanliness, as well as to lighting and other conditions.

The machine-tool builders have made advances along the lines that Mr. Nadin desires. Many machines are being equipped with ball and roller bearings, as substitutes for the old-fashioned plain bearings; and countershaft pulleys are found with ball bearings in place of bushings, that roll around very easily and require very little oiling, no attention and rarely replacement. Many of us do not have the forced lubrication that Mr. Nadin advocates. More of us will come to it later on.

I was rather surprised that the Chairman said what he did with reference to automobiles, because I believe that on one of our modern cars a few grease-cups need to be chased up with grease-guns or something of that kind occasionally.

CHAIRMAN HERRMANN:—That is very true. We do have grease-cups, but they are usually on bearings that do not make a complete revolution or very few revolutions, such as spring-shackles. In machine-tools we have spindles rotating at from 100 to 500 r.p.m. day in and day out, sometimes 18 to 20 hr. per day, that are lubricated with only an oil-can. This practice should be eliminated.

I refer further to a type of machine-tool on which we expect very often to produce work that is accurate within 0.0005 or 0.0010 in. We certainly cannot expect ordinary oil-can lubrication to take care of spindles running at fairly high speeds for long periods under these conditions.

B. NAGELVOORT:—The 1923 Michigan State Legislature passed some drastic changes in labor laws which went into effect on Aug. 29, 1923. These changes contained several clauses pertaining to the use of machinery. I have had placed on all our purchase orders a clause notifying the vendors that they must guarantee their machinery or equipment to comply with these revised labor laws.

I think that is very important. The first thing we do when we get a new machine is to see that it is safe to be used. If the things required by the law were incorporated into the design of the machine, they would be much more substantial and better in appearance than when made as additions by tinsmiths and machine repair-men who usually do this sort of work. Some of the manufacturers of woodworking machinery are coming to the front fast, but others need jacking-up.

I think this is something everyone in this State can take advantage of. Some of the States are farther advanced than Michigan in this kind of legislation.

A MEMBER:—I represent the sales end of the machine-tool industry. Frequently I have received complaint from a user of our product that a wheel-head, for instance, was not functioning properly. Upon investigation I found that a wheel-head that was, perhaps, 10 years old was being used. Fault was found because that head did not function in the modern way. It is, of course, the salesman's duty to try to teach those who are responsible for such installation that they should modernize; and it is, I will say, pathetic the way we salesmen have to worm around to get to the engineer to show him the advantages of a change in design. We are abreast of the times. We know these complaints are worthwhile, and our factories are working to bring about improvements. But the lack of reception that the sales representative gets in the offices of the engineering department of the biggest works is unfortunate and sometimes very discouraging.

We see, perhaps, the purchasing agent or an underling who has very little authority and must follow a requisition. If a requisition calls for something that is 10 years old, it is very hard to get something that is 24 hr. old substituted, for this reason: The man will say, "Well, we have a number of repair parts on our shelves and new ones will not interchange; and we want all our parts to interchange." The fact is that in many cases it would pay the company to take all the repair parts it has on its shelves, throw them into the scrap-pile and put in one or two modern attachments, and sometimes one or two modern machines.

Think of this: By the installation in one shop of just two features the hourly production was changed from 40 to 70 pieces with the same operators. I think it behooves engineers of the automotive industry to make it a practice to see at least four times a year the sales engineers who come into their midst.

H. L. POPE:—I would suggest that the machine-tool industry would be helped very much if the different State legislatures should enact uniform safety and guarding rules. If they could do that, the machine-tool builder would have to prepare only one type of guard to comply with the regulations of all the States.

MR. HEALD:—Considerable work has been done on guards for grinding-machines in connection with safety engineering work by the General Association of Insurance Men. The industry as a whole is greatly indebted to two or three men, one of whom is H. W. Dunbar of the Norton Co., who has done much work in that special branch. They have gone into the question of guards for

grinding-wheels and also of specifications for flanges. I do not know that any other committee is working as faithfully or as hard as they are with regard to other types of guard for other parts of other machines and for other types of machine.

Mr. Pope has brought up a valuable point, because the requirements for guards in some States are more than ludicrous; they are tragic. You will sometimes see a single belt coming down to a machine and the guard running 7 or 8 ft. up into the air; it comes down to a cone pulley that must be changed occasionally, and to do so you must open a side-door in a wire cage to get at it. In many cases a simpler design would insure the protection required.

GLENN MUFFLY:—I heartily endorse all that Mr. Nadin, Mr. Heald and the others have said. Cleaning up the externals of a machine-tool is just as important as cleaning up the external design of an engine. All gears and pulleys should be well protected and lubricated. I think we shall see more and more of force-feed lubrication on machine-tools.

MR. NAGELVOORT:—About 6 months ago we started a general cleaning-up in our factory. We have cleaned it very thoroughly. A report on accidents that has just come out for the last year shows some remarkable results.

In January, 1923, 3.8 accidents per 100 employes occurred and in December of the same year just 0.6 of an accident per 100 employes, less than one-sixth as many. Not a cent was spent on machine guards; what we did amounted simply to a general cleaning up, a rearranging and lighting of the factory.

CHAIRMAN HERRMANN:—Mr. Nadin referred to the oil getting through the bearings. Recently we put in a battery of the most modern type of lathe. Immediately the belts became covered with oil that ran out of the bearings. It seems to me that some guards should be put on the bearings or some precautions taken to prevent the belts from catching nearly all the lubricant used in machinery lubrication.

THOMAS NADIN:—The first point raised was with regard to the use of wood bushings. They do work successfully for moderate loads and speeds. I have had them running for the last 3 or 4 years with success in some cases, and without it in others. They should be regarded, I think, not as the ultimate, but as a possible temporary, way out of trouble.

The proper way to run a bearing is on an oil-film; and that should apply to a film bearing or a ball bearing or roller bearing. No substitute exists for an oil-film in any kind of bearing, whether it be made of wood, graphite or anything else.

The vacuum oil-cup that was offered has rather the opposite effect to that which I was advocating. It is very nice for supplying oil to the bearing, but after that what will the oil do? Probably run down to the floor or onto the belts, and eventually get on the ceiling, on the man, or anything but the bearing. So, the vacuum oil-cup, or any ingenuity expended on oil-feeding devices, is not what you want. What you want is to keep the oil in the bearings. That cup, of course, may have some value with bearings in which you cannot keep the oil without considerable trouble; but with a little scheming you can keep it in.

Mr. Heald referred to self-contained drives. They are rather outside the scope of my suggestions, but I think everybody agrees that self-contained drives are extremely desirable. If one can afford to invest the additional money in the drive and the power factor and the extra switch-gear, then they are what one wants.

Mr. Heald also said that machines which complied pretty well with the requirements of this paper have been built. I think they have been. Not all machines are bad ones. I think you can count the exceptions on one hand. They are very few.

I think somebody mentioned the Norton machine; that is undoubtedly an example of a very good oiling system. Nearly every bearing is taken care of. Another machine occurs to my mind, the Blanchard surface grinding-machine. Very careful thought has been given to the bearings on those machines. The machines, as you would expect, give very satisfactory results. There are one or two others as well, but the exceptions are very few. When anyone says, "Our machines are designed that way," ask him to name them. I think he will tell you that there are only four or five. They are not like anything they ought to be like.

A point was raised about machine guards, but I did not include that in my paper. It is, of course, a valuable point and also a troublesome one. Though the guards are getting better, they are too few and the machine-tool builder should spend a little more thought and money on gears and other points of danger so that the user will not have to spend his time designing and fitting guards on the machine after it has been installed in his shop.

As regards the difficulty of sales engineers seeing responsible people, I think that the trouble is really one of time and caused by the fact that only 1 out of every 10 salesmen that come has anything new to tell, and what he has to tell does not occupy more than 10 per cent of his conversation. Salesmen often come in and insist on discussing the A-B-C of machine-tools, whether you will or no, and sometimes you have to fight to get rid of them. So, sales engineers as a body are themselves very largely to blame. I make exceptions to that statement, of course, but the average interview with a machine-tool salesman is a matter of courtesy, not a source of instruction.

The reduction of the number of accidents, we all agree, is an important and a very desirable thing.

Our Chairman gave us a lead on the question of cost. He said you could not sell a motor car with such defects in it as I have mentioned. Mr. Heald objected to that. He said that there are cars in which oil-holes and a number of grease-cups require attention. I think Mr. Herrmann met this objection. Certainly, the shafts that revolve constantly at medium or high speeds on cars are all provided with automatic lubrication.

If you want to see machine-tool lubrication in its true perspective, you ought to look at it in this way: Suppose you were building a car that you had to oil with an oil-can every day, or every other day; could you sell it? I think you would find that you could not. You would be compelled to provide a better system of lubrication on the car. The question of the cost of the improvements in such a case would be governed entirely by the state of the market at the time they were made. It seems to me that the position of the machine-tool builder in eliminating defects in his product should be the same as that of the automobile builder in eliminating defects in his product.

THE COORDINATION OF RAILROAD AND MOTOR-TRUCK TRANSPORTATION

BY ROBERT C. WRIGHT

LACK of reliable data as to performance and cost and the rapid strides that have been taken in the development of the motor truck have hitherto prevented an actual experiment being made to demonstrate clearly the value of the motor truck as a possible adjunct to rail transportation; but the definite extent of the field of usefulness of the motor vehicle cannot be fully determined until motor transporters are charged with all the common carrier responsibilities commensurate with the privileges they enjoy in the use of the public highways. As a result of study, the Pennsylvania Railroad System has become convinced that the motor truck can cooperate with the steam railroad in three lines of activity: (*a*) in substituting motor trucks for rail transportation for handling short-haul less-than-carload traffic, (*b*) in motorizing terminals and (*c*) in door-to-door delivery service. All these can be combined naturally into a final plan, or each undertaken independently of the others.

Among the advantages of the motor truck in handling short-haul less-than-carload traffic are said to be a reduction in the number of handlings required, less exacting packing and rapidity of service. Locating freight stations at various points throughout the city for advantageously procuring competitive traffic necessitates duplicating certain cars and moving others in and about the terminals. But if all less-than-carload freight were unloaded and loaded from one properly constructed station, a large amount of transferring would be saved, heavier through-loading would be possible and the service would be more regular. It is asserted that a door-to-door delivery service would save the 2 days' free time now allowed for removing freight, save platform space, insure the prompt delivering of freight and prolong the adequacy of existing stations. This service, it is believed, could be rendered best by a separate company, responsible to the traders for the service and simply utilizing the rail carrier from station to station under a proper contract.

The conclusions drawn are that the field of the motor vehicle should be determined, that the motor vehicle should assume all the responsibilities commensurate with the privileges it enjoys and that rail, electric-line and motor truck transportation should be coordinated, each serving its own field and avoiding competition. [Printed in the March, 1924, issue of THE JOURNAL.]

DELIVERING LESS-THAN-CARLOAD FREIGHT BY MOTOR TRUCK

BY R. D. SANGSTER

PUBLIC interest in commercial activity is closely related to the cooperative functioning of the several principal kinds of transportation. As the details of the St. Louis system of using motor trucks for the terminal delivery and pick-up of less-than-carload merchandise as auxiliary to railroad transportation service have been previously described, the present discussion is devoted to outlining the practical working of this system and to demonstrating the regard in which it is held by both the shipper and the carrier.

The distinguishing feature of the St. Louis method, namely, the use of off-track freight-stations located at convenient points in the business district and a fleet of tractors and semi-trailers owned and operated by private transfer-companies, is said to have found constantly increasing favor with the public in the 16 years of its operation, so that it is now acclaimed as indispensable. As opposed to this system, a competing company using a universal freight-house and handling the freight by trap-cars is said to care for only 3 per cent of the tonnage of St. Louis proper. The opinions of various users, of investigating committees of the Interstate Commerce Commission and of a committee of the Chamber of Commerce of the United States of America regarding the relation of highways and motor transport to other transportation agencies are cited.

The effect of the store-door delivery plan is said to be the removing of railroad freight-stations from expensive land in congested parts of the terminal area to outer locations on cheaper ground, for service that would be fully as acceptable to the shipping public. That the railroads have not kept pace with the growth of traffic is indicated by the fact that in the last decade the value of manufactured products has increased over 200 per cent, whereas the carriers' investment in road and equipment has increased only 34.3 per cent; although the railroad tonnage has increased greatly, the terminal facilities as a whole have not increased, the interchange of carload and less-than-carload freight within connecting lines being the traffic most hampered. Terminal congestion is the main obstacle to good transportation and its effects are felt throughout a wide area, resulting in idle cars and a shortage of empty ones. To this might be added the fact that railroads occupying favorable locations for securing competitive traffic are loath to give them up; but if they were to take a broad view and average their advantages in one city with their disadvantages in another, a benefit common to all concerned would be realized. Experience during the war showed the advantages of cooperative operation and gave rise to the Transportation Act of 1920. Studies now in progress should be speeded up and more constructive methods of operation instituted.

Although the motor truck has been a factor for less than 10 years, its utility has been clearly demonstrated. The aggregate less-than-carload tonnage is not over 5 per cent of the total freight traffic, but the nature of the service, the revenue received and the cost of handling it bear a much larger ratio to the total earnings and expenses. One-half of this traffic is said to originate on one road and be transferred to another, and much of the freight handled in the larger cities is asserted to be connecting-line or transfer business. Taking cars out of service, the cost of motive power and the cost of rehandling add greatly to the expense. Pilferage; the loss of time of the terminal facilities, equipment, teams and crews; congestion of street traffic; the occupation of expensive real estate when less expensive sites would be equally or more suitable; large investments in non-revenue producing improvements; and the floor space now occupied for storage purposes by freight awaiting removal, are among the disadvantages that might be overcome; the advantages to be secured include the regulation of the time of delivery,

the reduction of congestion during the last receiving hours and the concentration and consolidation of freight into large units, all features that would inure to the benefit of railroads adopting motor-truck service for terminal operation.

Store-door delivery and the terminal handling of freight were recommended by the Interstate Commerce Commission at the time Manhattan pier stations were glutted with war material. Although the plan did not mature because the armistice cut it short, sight should not be lost of the fact that the report of the Commission would have established in principle the systems in use in the cities of Washington and Baltimore, which had previously been in review in formal cases that had come before the Commission. The reasonableness of the service was not at issue, but the fact that the railroads were paying the cost of the service, which they wished to avoid doing. Since that time store-door delivery has been unqualifiedly favored by Special Committee 4 of the Chamber of Commerce of the United States of America. [Printed in the April, 1924, issue of THE JOURNAL.]

THE DISCUSSION

CHAIRMAN F. C. HORNER:—This is the second meeting that the Society has held dealing with the general policies of how to apply the commercial motor-vehicle to transportation requirements. The scientific use of motor vehicles is of paramount importance to the automotive industry and to all transportation agencies throughout the Country; this is also true of the merchants and, finally, the consuming public, especially as to the economics of actual operations. What we are trying to do is to show how better to coordinate these various facilities, the motor truck, the railroad, the electric railways and the waterways, and to fit each in where it belongs. Through several committees composed of representative men from the transportation, mercantile and manufacturing fields, the Chamber of Commerce of the United States of America made an investigation of the transportation facilities of the entire Country, the object being to make recommendations that would show us how we can best accomplish this coordination in a scientific but practical manner.

Committee IV was the one that dealt with the Relation of Highways and Motor Transport to Other Transportation Agencies and, I think everyone will agree, made a most intelligent and practical report considering the complex nature of the problems involved.

When consulted about the subjects that we could deal with to the greatest advantage as this meeting, I suggested that we take the recommendations made in the Report of Committee IV and ask the speakers to base their remarks on those recommendations. My suggestion was adopted, and therefore it is hoped that you will freely discuss those recommendations and the papers that were presented here this afternoon. Bear in mind that a thorough ventilation of the factors entering into any problem, particularly one so complex and important as the proper coordination of transportation facilities, is the only effective way to disseminate practical ideas and keep us from running off the right track to our objective, a satisfactory solution.

P. G. FINDLAY:—What is the greatest distance over which this less-than-carload freight is hauled by motor trucks?

ROBERT C. WRIGHT:—From Philadelphia to Downington, Pa., 32 miles. We also have a motor-truck service in operation between Pittsburgh and Beaver Falls, Pa., and another between Philadelphia and Wilmington, Del.

MR. FINDLAY:—Is it the purpose of your Committee to limit the application of this motor-truck arrangement to the larger freight-stations, at least for the present?

MR. WRIGHT:—You are not to confuse the report on the National question with the action being taken by the Pennsylvania Railroad Co. in its desire to start something. The Committee deals with principles; our job is to find out how to put those principles into practical operation. My remarks have been intended to show what the Pennsylvania Railroad is doing to adopt the principle.

MR. FINDLAY:—But some of the freight systems go out of the city limits of one city almost into those of another.

MR. WRIGHT:—We will apply the method wherever the volume of less-than-carload freight is sufficient to warrant the relief. The need for relief naturally originates at the big cities. A tremendous movement takes place from cities like Philadelphia to the suburbs, or from New York City to short-haul points, but the movement from Harrisburg and similar cities is not so heavy. This short-haul proposition, the movement of short-haul less-than-carload traffic, is logically a step toward the final turnover to the motor truck. It must be done by degrees. Until the motor truck becomes responsible as a common carrier, I do not believe that the Interstate Commerce Commission would allow us to withdraw from the field without leaving the public with some stable means of transportation.

MR. FINDLAY:—That is just the point. For instance, regarding Philadelphia, Altoona, Harrisburg and various other cities, if you were to put this plan into effect in these different cities, how would the less-than-carload merchandise be carried or cared for beyond the final limits? Would it be done by a local process of handling this business as way-freight, or would the public be obliged to go into the trucking business? Where would you draw the line?

MR. WRIGHT:—We could not abandon this less-than-carload traffic because we have to maintain a service. For instance, for Ardmore or Wayne, Pa., two points on our line, we not only have shipments from Philadelphia, but also from Chicago and Detroit. We are handling that now by loading it to one of the destination points and there distributing it to other points by motor truck.

MR. FINDLAY:—Suppose you have a local shipment originating and terminating 30 or 35 miles distant from Philadelphia, would your present idea be to put that shipment into a way-freight train?

MR. WRIGHT:—No, that would be handled through the destination station. Suppose you lived near a station that was not a destination station, and you had a shipment beyond that point. The motor truck would pick it up at your station and carry it to one of the destination stations; then it would go in a car to the first destination point beyond, instead of being in a way-freight car that peddles freight to four east-bound or four west-bound stations. If it is to go beyond that zone, we must use whatever facilities are in effect beyond that zone.

MR. FINDLAY:—In other words, you harmonize and combine the local at the transfer point.

MR. WRIGHT:—We must do so until results follow.

G. T. CARLIN:—In Cleveland seven railroad lines have 15 terminals. The express company there issues as many receipts for less-than-carload shipments as all of the railroads combined. The difference lies in the ton-

nage per shipment. The express tonnage averages 82 lb. per shipment; the less-than-carload freight tonnage averages 656 lb. per shipment, or eight times the average weight of the express shipment. The express company employs 150 motor trucks to handle the express matter within an area of 90 sq. miles. On a tonnage basis, with 150 trucks to handle the same number of shipments but of only one-eighth of the weight, it would take 1200 trucks to make the door-to-door delivery and pick-ups of less-than-carload freight in Cleveland. Those trucks alone would cost $3.600,000, and the garage facilities to take care of 1200 trucks would cost, at a low estimate, $5,000,000. This would represent an expenditure of $8,600,000 in Cleveland alone. It is evidently a large proposition.

CHAIRMAN HORNER:—So far as I know, those who have been dealing with this question of door-to-door delivery are thinking of utilizing the available equipment that is on the streets today by organizing it into well-managed cartage companies capable of performing in the most efficient manner possible, rather than by setting up entirely new organizations with new equipment. Of course, it will no doubt be necessary to do this very thing in some cases, with the final result that like the boy's knife that had to have first new blades, then a new handle, and so on until he called it a new knife, we will in a similar manner "reconstruct" our cartage organizations in both personnel and equipment, and eventually build up entirely new agencies to perform this coordinated transportation service in given terminal areas.

J. F. MURPHY:—It has been said that no greater contribution could be made to the welfare of the Country than through transportation development by the picking up of freight at given points and delivering it at its destination. However, I do not believe that the plan could be carried out except by utilizing existing automotive and other terminal transportation facilities, not excepting the railroad facilities that are available in large cities; considering each city as a unit because each city has its own peculiarities that must be treated differently. I believe that if an optional store-door delivery can be effected, the railroad terminals can be relieved and that the existing railroad facilities in many cities will be adequate for a decade or more. Motor-vehicle operation in St. Louis has proved that. The railroad freight-houses of the Eastern lines are in the "greenland" of East St. Louis and are not scattered around the city of St. Louis. We utilize off-track stations and the outbound business is concentrated in these stations and loaded in large motor units. By this method the company I represent has relieved vehicle congestion on the streets. We now have about 200 motor vehicles in service; 6 years ago we had 600 horse-drawn vehicles.

Congestion of vehicular traffic is the most important difficulty with which municipalities have to contend. Something must be done to relieve the streets of these vehicles, and it can only be done by intensive loading of equipment. Intensive loading of motor vehicles will also bring about intensive loading of freight-cars by the method described by Mr. Wright, taking the freight from various points in the city and loading it into the cars and, conversely, by relieving the freight platforms of the freight as quickly as possible. This can be brought about by store-door delivery, but store-door delivery must be optional and I believe it must be worked out with the existing trucking instrumentalities of the large cities where it is put into effect; the point is that its being optional must be taken into consideration and the present facilities must be utilized. The idea has not yet been sold to the merchants, but when they realize that transportation service does not mean rail transportation alone but includes vehicular transportation to their doors as well, and that the latter part of the service is just as essential as the first part, they will be willing to pay for it.

NEW ERA IN TRANSPORTATION

C. R. SCHARFF:—Service is about the most interesting feature today to the industrial organization, and the less-than-carload shipment has always been a matter of guesswork so far as service is concerned. If door-to-door delivery will eliminate congestion in terminals, which no doubt it will, and give us a service that can be depended upon, then we have found something that will eliminate the necessity for elasticity in the equipment because it will allow the consumer to order his material so that it will flow evenly. The ordinary consumer today orders far in advance on a less-than-carload shipment, because he has no idea how long it will be before he receives it. If he receives it ahead of time, he will leave it at the terminal station because he does not need it. If he does not receive it when he needs it, he will condemn the transportation company's service, and is likely to ask the railroad company to spend enough money in tracing the shipment to offset any revenue that might have been realized on it. From personal experience, particularly through the Toledo gateway, we have had as many as 300 to 400 merchandise cars awaiting transfer on account of congested terminals. If that sort of congestion is eliminated, and any approximately guaranteed service is made on less-than-carload shipments, we will have a new era in transportation.

MR. WRIGHT:—That is what the Pennsylvania Railroad is trying to do. In the door-to-door delivery service, the railroad need only carry the freight from the outskirts of one city to the outskirts of another, and this will eliminate all the time required to go through the downtown traffic congestion. The railroad companies do not expect to pay part of the drayage, but they intend to make up to the rail-motor line the difference between drayage from the outlying point and drayage from the the downtown point, which the shipper usually would pay. By avoiding this terminal movement and locating the unloading station out in the "greenland," we believe that a few miles farther by truck is not material enough to prevent dispatching quickly. We will do much more to make the less-than-carload freight handling a dependable service because no obstruction will be encountered at the dispatching yard. All sorts of difficulties must be worked out completely by us, and we must find some method of coordinating this service. We want to utilize the independent truckmen, but much thought and consideration are required to get this proposition down to a practical working basis.

MR. SCHARFF:—I had in mind particularly the inventory feature; it would be the biggest point for store-door delivery. A saving would be effected there which would go a long way toward offsetting any additional cost that the service might entail.

CHAIRMAN HORNER:—It must be dependable service. That is of paramount importance. I think it is generally realized that it is of no use attempting to do this thing in a half-baked manner. Each case must be carefully analyzed from all standpoints. I think that Mr. Hoover's suggestion, made at the Washington Conference held under the auspices of the Department of Commerce, should be carried out; he said that he would like to see one or more demonstrations of organized collection and

delivery of less-than-carload freight made in this Country. To make two or three demonstrations at very congested points would require a great amount of thought and effort on the part of those who are to carry it out. It would also demand the very closest cooperation of everybody involved in the handling of this traffic, especially between the transportation interests and the merchants, the patrons of those interests. In other words, we must get the highest degree of teamwork and concerted action from all concerned; otherwise we cannot hope to reach our objective—efficient, economical terminal cartage.

MR. FINDLAY:—Specific attention should be called to the tremendously speeded-up service that will be available for carload traffic by relieving the carriers in their congested terminals along the line of the handling of this great volume of less-than-carload freight. This will tremendously speed-up the handling of carload freight, which is of equal importance.

CHAIRMAN HORNER:—You are entirely right. The recommendations of the Report of Committee IV state very definitely that what is generally known in the East as team-track carload traffic should be included in the arrangements for an organized system of collection and delivery from the outset. I am in full accord with this idea.

MR. CARLIN:—It seems to me that the intent of my previous statements may have been somewhat misunderstood. I made them only as an illustration of the large volume of work that must be done to get into this thing directly. I gave the illustration for Cleveland from personal knowledge because, at the peak period of express shipment, those 150 trucks are operating to their maximum capacity. I figured tonnage, not shipments, because I know that express shipments are more bulky than the ordinary less-than-carload freight shipments. I figured on the basis of 2-ton trucks, although we have 2, 3½ and 5-ton trucks in service at Cleveland. But that was only an illustration of one proposition compared with another on a tonnage basis to show, for one city, what an enormous amount of calculating must be done to handle door-to-door delivery for 15 terminals. As to whether the railroad companies are financially able to build elaborate terminals in the suburbs of the cities, I suppose that is being given consideration. The Orange Street Terminal in Cleveland cost about $7,000,000.

MR. WRIGHT:—If we motorize our terminals and undertake to move traffic from an outlying station to our regular station by motor truck, the door-to-door delivery supplants that gradually. It cannot be done at a leap; it must be "sold." One method graduates into another. As the door-to-door delivery is effected, the motor truck at the terminal is relieved so that probably the volume of traffic will not be very great, but there will be just a gradual change in its course. By having an organized system, about two-thirds of the present number of vehicles will serve the same purpose.

MR. CARLIN:—It would require a large terminal to handle 500 cars a day.

MR. WRIGHT:—That depends on the tonnage in each car.

MR. SCHARFF:—As an instance, if the New York Central Lines that run down 11th Avenue, New York City, were removed and if the Company should throw open that property for business purposes, might it not compensate them for any expenditure the Company might make in the suburbs of New York City? How heavily are the express trucks loaded that Mr. Carlin mentions?

MR. CARLIN:—The 150 trucks we have are going constantly during the peak period to maximum capacity. But the amount of express matter is as nothing compared with the amount of less-than-carload freight on account of the average bulky but light weight of the express as compared with the less-than-carload freight. That is shown conclusively by the 656-lb average shipment for less-than-carload freight and the 82-lb. average for express shipment.

M. C. HORINE:—If I understand Mr. Carlin's argument correctly, it is that store-door delivery of freight in Cleveland would require 1200 trucks on a basis of the comparative tonnage of less-than-carload freight and express matter, the latter requiring 150 trucks. The error lies in the comparative weight of the average less-than-carload freight shipment and the average express package, which is 8 to 1. The answer is the results already achieved in St. Louis as mentioned by Mr. Murphy. Mr. Carlin bases his conclusions on an assumption that 2-ton trucks will be used. I think that Mr. Murphy does not use any 2-ton trucks.

MR. MURPHY:—We use nothing smaller than a 5-ton truck.

MR. HORINE:—Just as car-loading of less-than-carload freight is greater than the loading of express matter and just as the use of store-door service increases the car-loadings, so the truck-loading of less-than-carload matter should be heavier than with express matter and so also truck-loadings would be increased by store-door delivery. It may be perfectly true that 1200 trucks of the type used by the express company would be required to handle the less-than-carload freight traffic of Cleveland, but I do not think 2-ton trucks will be used. I think it more likely that trucks of 5-ton or greater capacity will be used.

MR. CARLIN:—In some cities it is not allowable to run trailers, or even semi-trailers. I quoted tonnage only on the basis of 2-ton trucks. We know very well that 5-ton trucks probably would be used for less-than-carload freight. I was figuring on tonnage capacity as compared with less-than-carload rates; the ratio is 8 to 1.

CHAIRMAN HORNER:—Let me gain remind you that in general the idea is to use existing equipment so far as possible, but to organize it properly and operate along scientific lines.

R. E. PLIMPTON:—Will Mr. Wright give more information about the system of operating the trucks he is using? As I understand it, he handles that work by contract and the trucks he uses are not subject to any regulation or taxation as recommended in the report of the Committee. How is the truck operation controlled?

MR. WRIGHT:—We have reached a firm opinion that the railroad company does not want to go into the trucking business, for various reasons. If the railroad company starts in the trucking line, it will be in competition with all the private truckmen. That is not a railroad field. In England, the railroads wanted to get the trucking business to drive the other fellows out of the business, and they had to charge more for freight so as to get some money to beat the truckmen. We do not believe we are truckmen. Our idea is to have this work done by contract.

So far as their being substitutes for the rail carriers is concerned, the trucks do not need to be common carriers, but private facilities hired for certain work. When, however, they get properly into this rail-motor line, they will have to be common carriers. Finally, I think these private truckmen will come under regulations, but not yet, because the freight is received and

delivered as railroad traffic. The railroads take all the responsibility. The trucks are no more than an instrument of the service, so far as the public is concerned. They are simply substitute facilities, but they will deal directly with the public and not with the railroads when they come to the common-carrier standing.

QUESTION:—What is the longest haul for which the motor truck would be efficient?

MR. WRIGHT:—That varies greatly in different parts of the Country. On the New England roads, say 15 miles; on other roads, say 50 miles. That matter will have to be developed. In the very careful study the State of Connecticut is making, it has taken every road and every truck and listed the traffic. We are perfectly willing to experiment and leave the subject open to negotiations later on, but it all depends on the character of the roads, the weather and other things. When I say "short haul," I mean about 30 miles.

JOHN YOUNGER:—Upon reading the Committee's report, it appears that the railroads are trying to limit the maximum range of the truck to a certain number of miles. My opinion is that so many factors enter into the situation that this cannot be done. One of the important factors is the ratio of the loading time to the distance that the truck traverses. For example, a load of sand can be discharged from a hopper into a truck or freight car immediately, and in that case a very short haul with the motor truck would cost about the same as a similar haul on the railroad. But for household furniture, which requires a great amount of time for packing, the truck can run say 100 miles and still compete with the railroad. In the case of a factory that made particularly brittle china, it was found better to load that china into a truck at the factory and run about 250 miles, simply because of the other elements that enter, such as the cost of breakage. I think the railroads will have to devise a classification of commodities as well as a classification of distances.

MR. WRIGHT:—That is perfectly true. For instance, it costs about $12 to case a piano for shipment by rail, but you can throw a piece of rag over it and ship it by motor truck. Those are the things that establish the field of the motor truck. But the motor truck carries no responsibility. A friend of mine shipped his furniture by motor truck to utilize its great advantage, but it burned up on the way and he got nothing. Before the public will trust itself to motor trucks, the trucks will have to have some commercial standing.

CHAIRMAN HORNER:—We cannot consider this subject as all black or all white; there are shades of color in it. For example, it may be economical to haul by truck for 30 miles in one locality under one set of conditions, whereas it may be most uneconomical in another case to haul by truck for even 15 miles. We must analyze each problem and the conditions that surround it separately. When I had charge of a fleet of motor trucks in New York City some years ago, we were hauling sand, gravel and brick with 5-ton motor trucks from the docks to a building. We made 20 loads per truck per day of sand and gravel that we could load out of a hopper in 3 or 4 min., but only 3 loads of brick because the brick had to be tossed up from the brick barge by one man, caught by another man standing on the stringpiece and thrown into the truck. We cannot draw any sharp line and say exactly what distance is the economical limit for the motor truck. Generally speaking, those who are in a position to know have a good idea of what the factors are that must be considered in making a price to haul a certain commodity a given distance by motor truck, and appreciate that all things being considered the final answer as to whether the traffic goes by rail or goes by road depends on which method is the cheaper for the shipper. Each problem must be analyzed carefully from all standpoints. The horse-drawn vehicle has and will continue to have a place in congested centers, but that place will be reduced very materially as our methods in handling motor equipment become more scientific.

MR. YOUNGER:—Many trucks are going about today loaded perhaps to an average of 30 per cent of their capacity; that is, 70 per cent idle capacity is available. If we concentrate on the problem, the average loading of trucks that are in use will be increased.

CHAIRMAN HORNER:—On cartage vehicles handling less-than-carload freight in England, they get an average of from 60 to 70 per cent load efficiency as compared to the 30 or 40 per cent we get from our vehicles engaged in a similar class of transport over here.

MR. YOUNGER:—In view of the restriction of terminal areas in the central portion of cities and the great cost of changing over to a motor-truck system, would it be possible for the railroads to liquidate some of their central freight-terminals and build outlying terminals with the money so raised?

R. D. SANGSTER:—A number of the railroads in the larger cities are improving their freight-houses; in other cities they are rebuilding them as industrial terminals doing more or less warehousing of freight, to reduce the cost upon the carrier of maintaining itself in an expensive downtown location. To reduce the cost the carriers have been forced into the policy of improving air rights and renting part of their upper-floor space. It would be much more economical for the carrier to sell its downtown realty so far as possible, and certainly to avoid increasing its investment in such localities, and locate in the outskirts of a city where its business can be handled with very much greater facility and the local shipper and the consignee would be served equally as well by the motor truck, if not better.

I think we may accept it as entirely settled that, in connection with the city terminals where the pressure is greatest and the congestion problem the worst, the municipal authorities will cooperate to the extent of their lawful power in making a success of the use of the motorized vehicle in conjunction with the rail haul.

L. S. HORNER:—The real solution of the problem in any city would be given by a proper demonstration of what size and kind of container is to be used for moving the freight from the terminals to the store door, or from terminal to terminal. If some city were to find out that another city was able to move its freight from terminal to terminal or from terminal to store door by better containers, without any doubt the laws of the former city would be changed to provide more economical transportation movement.

CHAIRMAN HORNER:—I asked one of the highway engineers in England what economical weight or size of motor vehicle he would like to have specified for the roads he had to build within his particular district. He said: "We ought to build the roads to withstand any traffic that it is economical to handle by motor vehicles over those roads."

C. M. MANLY:—Anyone who investigates the traffic problem in New York City, especially the increased fire hazard due to the present congested condition of its streets and the enormous cost of the delay of moving traffic, ought to be impressed by the fact that the methods of improvement suggested would be no more expensive

than to do business the way they are doing it now. All this matter of how much vehicle load the law ought to permit, or how much load a road can carry, is entirely a matter of what is necessary to avoid the increasing cost of doing business in the haphazard way we are trying to do it now because we have all kinds of inadequate receiving and shipping facilities and the inefficient use of the amount of street space that we have. Half of the vehicles involved in most cases of traffic congestion have no right to be in a stationary position on the streets at the time. The value of the city property is so stupendous that the people themselves will demand a more efficient use of the streets. Congestion of traffic and the enormous losses that are likely to occur at any moment in connection with a large conflagration constitute the biggest problem in New York City.

There is discussion about double-decking the streets. What is needed is efficient use of the street space we have. No efficiently organized and operated manufacturing establishment would for a moment permit the aisles of its factory to be inadequate for the loads coming on them or permit them to be congested by inadequate facilities for handling the material being moved or an inefficient use of the facilities provided.

CHAIRMAN HORNER:—You have emphasized the recommendations contained in the Report of Committee IV, and the sentiment of this meeting as well, that the traffic congestion on our streets must be reduced. A way to do it, or at least to assist in doing it, is to get a higher load-efficiency of the vehicles that are using those streets both for passenger and freight transportation purposes.

PRESIDENT H. W. ALDEN:—This is the culmination of the year's transportation work. We are faced by a new era of transportation and with a transportation problem that will be solved without any doubt.

IMMIGRATION

NEVER in the history of the world has a migration of such magnitude taken place as that to the Western Hemisphere in the last 100 years. The rich natural resources of the new countries, the improved means of transportation and communication and the rapid increase in European population have been the chief factors contributing to this movement. The United States has received by far the greatest number, in not a few years more than all of the other countries combined.

During the war immigration from Europe practically ceased; but in 1921, just before the present quota law went into effect, it rose to 664,000. The total immigration in the last fiscal year, which ended June 30, 1923, was 523,000. Only twice since 1896 has the number of Northern and Western Europeans admitted exceeded that of the Southern and Eastern, in 1919, when European immigration was practically at a standstill, and in 1923, under the restrictions of the present law.

It is a striking fact that about 17,000,000 immigrants, or nearly one-half of the total in the last 104 years, have come to this Country in the last 25 years. Of this number 4,863,000, or 29 per cent, have been Northern and Western Europeans, and 11,081,000, or 65 per cent, have been Southern and Eastern Europeans.

The result of this heavy and continuous inflow of foreign peoples to the United States has been an unprecedented growth in population; and it has hastened the phenomenal industrial development that has brought about fundamental changes in our economic position. The desirability of immigration from the point of view of the receiving country depends mainly on two things; the quality of the immigrants and the condition of the domestic labor market.

It appears that this Country has definitely passed the "under-populated" stage and that henceforth the economic effects of immigration must be closely watched. We are now a creditor country instead of a debtor country, and our manufacturers and investors are seeking foreign markets. The withdrawal of European capital from American industry, the investment of American funds abroad, and the decline of our merchandise export balance, all reflect the lessening of our capacity for the absorption of foreign labor in expanding industry.

Increasing population in this Country has raised land values to such an extent that the growing of wheat for foreign markets, where it must come into competition with wheat from Canada, Argentina and Australia, has become a doubtful project.

Ample opportunity still exists for immigration, intelligently administered, to contribute to the Country's progress. The chief problem is that of selection, and in proportion to our success in meeting this problem we shall need less to rely upon arbitrary restrictions.—*Guaranty Survey.*

ASBESTOS

IT is estimated that the annual consumption of asbestos brake-lining is 70,000,000 ft., of which 15,000,000 ft. is in new cars and 55,000,000 ft. in the replacement market. Only within the last 50 years have asbestos products been manufactured on a commercial scale. The United States holds first place in their manufacture, yet it produces only 1 per cent of the total world output of raw asbestos. More than nine-tenths of the asbestos consumed in this Country is imported. Nearly the whole amount comes from Canada, although considerable quantities at present come from South Africa.

Asbestos is the only commercial fiber of the mineral kingdom. Its high resistance to heat and chemicals and its insulating value as a non-conductor of heat and electricity, coupled with the fact that it can be spun and woven, assure its usefulness in modern industry. The longer fiber is used for spinning and weaving asbestos fabrics, ropes, brake-linings and engine packings. The shorter fibers are used in the manufacture of asbestos cement, shingles and lumber, the employment of which is rapidly growing in the building industry.

Asbestos rock is generally quarried. High-grade rock is broken and fiber removed by hand. This long, high-grade fiber is known as crude asbestos. Rock that is not hand cobbed is sent to a mill, where it passes through the processes of drying, crushing and fiberizing. The fiber extracted from the rock by the milling process is then graded.

In the United States, deposits of asbestos have been found in Arizona, California, Georgia, Idaho, Vermont, Maryland, Wyoming and Oregon. The mines in Georgia have been exploited for many years, and the mineral mined there is suitable for spinning. The Arizona deposits are of a chrysotile variety that is superior to the Canadian product for electrical welding and for blast-furnace uses, as it is less subject to decomposition from excessively high temperatures. It is doubtful, however, if many deposits in the United States justify development on a large scale.—*Commerce Monthly.*

THE FALLACY OF PRICE-FIXING

EVERY period of low prices creates a demand that prices should be regulated so as to afford a fair return to producers. As a matter of fact, however, it is production instead of prices that is the proper subject of regulation, and prices are the only effective agency by which this is accomplished. To propose the regulation of prices is to take hold of the situation at the wrong end. The population distributes itself in the industries according to the demand for products or services as shown by current prices. Consumption also is shifted by prices. There are few things for which there are no substitutes. Prices are an automatic signal to producers, they reflect the wants of consumers, they are to be interpreted and obeyed as promptly as possible, instead of regulated. You want a thermometer to aid you in regulating the temperature of your home, but you do not want to regulate the thermometer.

The entire price-system is a highly complex one, in which changes in the volume and in the methods of production are forcing price-changes all of the time. It is too complicated a system to be managed arbitrarily; it must work freely and automatically to make the adjustments that are constantly necessary to maintain the equilibrium.

Prices usually are performing an economic and useful function at the very times when they are most complained of. The real disorder is in the relation between supply and demand. If there is a short crop of something, rising prices have the effect of compensating the producer in some degree for his loss in quantity, and at the same time exert an influence among consumers for economy in consumption and in the use of substitutes, thus making the supply go considerably farther.

Withholding from Market

It is a common opinion that if producers are organized and strong enough to withhold supplies from the market they will be able to name at least what they regard as "fair" prices, but when the test comes success depends upon the right adjustment of price, so that demand and supply will be equalized. The Dairymen's League of New York, of which some 75,000 farmers are members, dominates the milk situation there, and upon it falls the responsibility of adjusting the prices paid to producers and the prices charged distributors so that demand and supply will meet and satisfy each other. It is a well-managed organization, but it frankly says that the price of milk cannot be fixed arbitrarily. The price paid the farmer must bear a relation to what he can get for other farm products; otherwise the League would soon get either too much milk or not enough; and the price to consumers must bear some relation to the prices of other foods, in order that the supply may be disposed of. Here are adjustments to be made on both sides, and they are largely by experiment. There is no work here for a price-fixing authority outside of the business and not very much scope even for one that is inside of the business. The conditions fix the price.

Copper is produced for the most part by large companies that have been rather closely associated through selling agencies. The copper companies have been referred to as an example of producers who are able to control the prices of their products, but the fact is that, with the exception of several months last spring, copper has been selling since 1920 below the average price of 1913. The price today is under 13 cents per lb. and the average in 1913 was above 15 cents. Many copper companies are either shut down or producing at a loss, but the low-cost companies are producing enough to supply the market, just as the low-cost producers of wheat in Canada are making the price for wheat in the markets of the world.

The manufacture of automobile tires has been developed to the point of over-production, with the result that in the past year profits have been scant for even the low-cost producers, while others have run behind. This may seem strange in view of the enormous increase in the number of automobiles in use, greater in 1923 than in any previous year, but the business has been over-stimulated by its own prosperity.

No immunity from competition or assurance of profit will be found anywhere in business life. In every line of business will be found people who are losing money and are on the ragged edge of bankruptcy, others who are just breaking even, others who are making small profits and others on a rising scale of profits. A new industry, like that of motor-car construction, affords unusual opportunities for gain, but competition is sharp everywhere. Easy money is the exception in business, and on the whole I doubt if there is any business in which a smaller percentage of proprietors are actually forced out of business than in farming.

One might think from much that is written on the subject that there is danger of general desertion of the farms unless artificial means of some kind is adopted to improve the returns, but it is obvious that before any considerable percentage of farms were deserted the falling off in production would send prices high enough to check the movement.

Crop Acreage

Nothing is so hard to go up against as an economic fact. Hard times result from disregarding economic facts. I do not believe that any serious over-development of agriculture exists, although a moderate movement to the town industries would help to make our agriculture more independent of Europe. The total acreage of all crops, according to the Department of Agriculture, was 311,293,000 in 1909; 334,268,000 in 1914; 375,687,000 in 1919; 371,711,000 in 1922; and 372,829,000 in 1923. This is an increase of 61,536,000 from 1909 to 1923, or about 20 per cent in 14 years, which is a little less than the percentage of increase in population and indicates that with a proper distribution between the various crops the situation may readily right itself.

It should not be overlooked that any general aid to agriculture may have the effect of counteracting the very tendencies that are necessary to place it on a sound basis. Price-fixing, to be successful, must be accompanied by the regulation of production, thus artificially bringing supply and demand together, but that is impracticable on a large scale. It is proper for the Government to gather information bearing upon probable crops and market conditions, but the individual farmer must use his individual judgment in directing his operations. And since the Government cannot regulate production, it is in no position to assume any responsibility for prices.

The farmer has no chance of ever being able to exercise the degree of control over prices that certain highly organized labor bodies exercise over wages; moreover, the general scheme is unsound because certain groups by reason of their strategic positions in industry have a great advantage over others. Finally, if the plan was workable at all, it would divide society into warring factions, emphasizing conflicting instead of mutual interests. It would be worse than socialism, for it would be syndicalism, the end of individual liberty and of reward for individual efficiency.

Farm Population

No fixed number or proportion of people must be farmers. One hundred years ago 75 or 80 per cent of the population were farmers. Now scarcely one-third of the people live on farms. The fact that a smaller percentage of the population than formerly is able to provide the food supply is not something to be deplored; it represents a social gain; it has released workers for other services and resulted in a great diversification of industry and a multiplication of comforts and satisfactions.

We live in a competitive society, and the merit of it is

in the fact that an incentive is offered to everybody to improve industrial conditions and increase production. Every individual producer, whether on the farm or in any other industry, must understand the importance of practicing the best methods and keeping up with progress in his line. The man whose production is below the average always will have a hard time. Nothing but economic pressure will move masses up to new standards of productive efficiency, and the whole idea of having the Government guarantee fixed returns to save them from the necessity of moving up is in conflict with the principle that an obligation is imposed upon everyone to be self-supporting and find a place where he can be useful.

The outlook for agriculture is an encouraging one. The worst of the derangement has been seen and steady improvement may be expected. The margin of surplus for all our farm staples is very small. Furthermore, nowhere in the world are any large areas of land suitable for diversified farming and likely to be rapidly settled. With the rapid growth of population, not only in this Country, but in Europe, the readjustment is bound to be effected speedily.—G. E. Roberts.

THE NEGRO IN INDUSTRY

FOR 50 years, the North has been sending money into Southern States for the education of the negroes. We are only just beginning to reap the benefits of this expenditure and to realize that we have had a splendid source of labor supply at our back door while we have been moaning over the decrease of immigration from Southern and Central Europe.

This brings us to the question of the opportunity for employment and advancement of the negro in industry. Will he be able to qualify, to make good on the job? It is possible to find almost any answer to these questions. Some foremen say his opportunity is most limited, and that he cannot qualify. Others will hire him in preference to members of any other race, even though they recognize that he may have shortcomings peculiar to the negro alone. Probably the best answer to these questions is to be found in the actual experience of plants hiring a considerable portion of negroes, and over a period of years. While 20 factory heads who were interviewed did not agree on all matters concerning possibilities for the colored migrants, they did all point to certain fields in which his employment was considered as being very desirable.

In judging the available opportunities and the negro's ability to fill them, it must be remembered that with but rare exceptions he has had to start at the very bottom of the industrial ladder upon his arrival in the Northern cities. This generally held regardless of his previous education or trade experience. Therefore, any progress he has made to better classes of employment must be credited to his own ability and its recognition by employers.

Twelve foundries or plants primarily engaged in foundry work report that from 10 to 60 per cent of their plant employes are colored. The average for these plants is 33 per cent negro workers. An equal number of important machinery factories report but a slightly smaller average of all employes as being colored migrants. In all but one of the foundries, it was found that the negroes have advanced from labor to semi-skilled work and finally to skilled positions. These employers hold that the Southern boys are doing their work fully as satisfactorily as did their predecessors and often more so. Of 442 negroes employed in one plant making materials requiring accuracy and rather complicated skill, 237 are engaged in the most skilled portion of the production, 128 are on semi-skilled or routine machine jobs and but 77 are doing common labor. The firm has used colored labor for nearly 10 years and their people have developed from the ranks of the laborers.

While it would be pure guess to state now what positions may or may not be efficiently handled in the future by the Southern negro, experience thus far has established the fact that they have not as a race failed in any class of work upon which they were given a fair trial. Although during the last 5 years their range of opportunity has been greatly widened, their field is still limited because of a lack of understanding by both employer and employe and in some instances because of the color prejudice. It is almost unanimously agreed that during the time they have been used to any great extent in Northern industry, the negroes have made as rapid progress to better jobs as have immigrants who came in on the same footing. It is generally acknowledged the negro is no longer an emergency factor in industrial employment, but that he is here to stay, with the probability that his numbers will increase as years go by.—J. B. Abell in *Trade Winds*.

A HELP TO PROGRESS

INDUSTRIES in which the manufacturers are most ready to interchange the results of their experience and who have the fewest trade secrets, have progressed more rapidly and have brought their products to a higher state of perfection, generally with a reduction in costs, in less time than have those who fear this kind of cooperation for competitive reasons.

The automobile industry is an example of extraordinarily rapid progress in a field where practically no mechanical secrets exist. The engineers, designers and production managers of the automobile plants meet several times a year at their conventions and at special meetings of the Society of Automotive Engineers, and the freedom with which ideas relating to design and shop practice are exchanged would be a revelation to many manufacturers and executives engaged in some other machinery industries. Articles relating to the practice in automobile plants are continually being published in the technical press, and it is of particular interest to note that the automobile builders who most freely cooperate in the exchange of ideas are usually among the leaders.

In some other industries a different policy prevails; very little information on either the design of the machinery built or the practice in the shops, is published or presented before conventions of engineering societies. It is noticeable that industries in which manufacturers are reluctant to give out any information, each one working out his own problems without the assistance that cooperation with others would afford, lack the incentive to adopt and utilize the latest developments in practice. Modern machine tools that have proved their value in other industries for similar work have been introduced with difficulty or not at all. Those who give out no helpful information naturally receive none and usually are not to be found in the procession of industrial progress.

An interchange of ideas between shops engaged in the same industry, either through papers presented before engineering societies or through carefully prepared articles appearing in the technical press, helps both the writer and the reader. Some of the methods guarded as trade secrets are relics of the past, inferior to some of the advanced processes that have been developed recently.—*Machinery*.

Standards Committee Division Reports

STANDARDS COMMITTEE action toward approving the accompanying Division Reports will be taken at the Summer Meeting on Thursday morning, June 26, in the Meeting Hall in the Monmouth Hotel, Spring Lake, N. J. The reports are published in this issue of THE JOURNAL in order that those interested may have sufficient time to study the recommendations prior to the Standards Committee Meeting. This meeting will be in the nature of a public hearing.

Non-Members of the Standards Committee or of the Society will be welcome at the Standards Committee Meeting and their comments on the Division recommendations will be carefully considered.

Special attention is called to the introduction by Charles M. Manly, vice-chairman of the Standards Committee. This reviews the function and scope of the several organizations now taking an active part in automotive standardization.

OWING to the great activity in automotive and national standardization, it is advisable at this time to review the work of the different organizations taking an active part in standardization affecting the automotive industry.

The work of the Society's Standards Committee needs no introduction. The following Division reports submitted for Standards Committee action at the Summer Meeting exemplify a continuation of standards work that originated in the Mechanical Branch of the Association of Licensed Automobile Manufacturers about 20 years ago. Since this work was transferred to the Standards Committee of the Society of Automobile Engineers in 1910, Divisions have been reporting to the Standards Committee semi-annually, until there are today in the S. A. E. HANDBOOK about 600 standards that have been approved by the Society. The accompanying chart indicates the organization of the present Standards Committee; there being 9 automotive divisions and 19 parts and materials divisions, besides several special and co-operating committees. The current work of the Standards Committee is reported monthly in the Tentative Standardization Work department of THE JOURNAL.

It will be appreciated that with over 300 technical societies and trade organizations actively engaged in standardization in this Country, standardization activities must be coordinated if a needless overlapping of standards is to be avoided. This is of commercial as well as of technical importance, as conditions might confront a producer of a material in which a certain grade of his product would be acceptable in one industry and not in another, even though the real requirements of both should be identical.

To coordinate this work, a national agency has been established to serve as a clearing-house for standards. This clearing-house, known as the American Engineering Standards Committee, is an organization composed of representatives of 9 leading technical societies, including the Society of Automotive Engineers, 7 Governmental departments and 19 trade organizations.

In carrying out its operations as a clearing-house for coordinating the standardization in this Country, the chief function of the American Engineering Standards Committee is to assure that all organizations interested, whether members of that body or not, are properly represented on the sectional committees. The sectional committees are generally organized by members of the American Engineering Standards Committee which are designated as sponsors. The sectional committee reports must be approved by the sponsors before they can be approved by the American Engineering Standards Committee as American Standards. This procedure is indicated in the accompanying chart. It should be noted that, whereas nearly all other societies and organizations approve sectional committee reports by the single approval of its governing body, our Society refers all sectional committee reports to the proper Divisions of its Standards Committees, these reports having to be approved in turn by the Standards Committee, the Council and the Society Members by letter ballot before they are transmitted by the Society, acting as sponsor, to the American Engineering Standards Committee. Unless the sectional committee reports are approved by all sponsors of the sectional committee, they cannot be approved by the American Engineering Standards Committee as American Standards.

Since the Society became a member of the American Engineering Standards Committee in 1920, it has been designated as a joint sponsor for seven projects. The complete personnel of the sectional committees appointed for these seven projects represents 41 organizations. The accompanying chart indicates the sponsorship for the seven sectional committees for which the Society is co-sponsor. In addition to the projects for which the Society is acting as a spon-

VICE-CHAIRMAN CHARLES M. MANLY

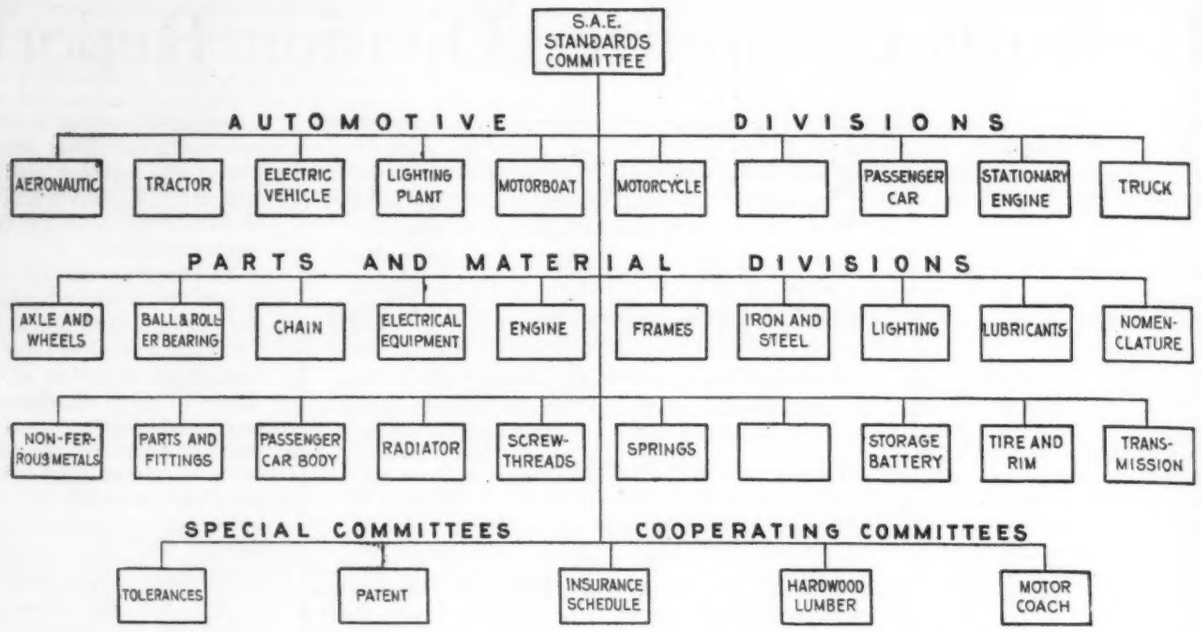


CHART SHOWING THE SOCIETY'S STANDARDS COMMITTEE ORGANIZATION

sor, it is represented on seven other sectional committees whose work is of interest to the automotive industry.

It is, of course, generally appreciated that S. A. E. Standards and Recommended Practices are not mandatory in any way. In other words, the work of the Society relates primarily to the formulation of standards, no thoroughgoing aggressive effort being made to have the standards adopted in current or future practice. Recognizing the need for the elimination of waste in industry, one of Secretary Hoover's first actions in the Department of Commerce was to establish the Division of Simplified Practice at the City of Washington to serve industry in bringing about the adoption in practice of existing standards. In view of the work of the Society in the automotive industry, it was considered advisable to establish an Automotive Simplified Practice Committee to further the adoption in current practice of S. A. E. Standards and Recommended Practices.

At the second unofficial conference of the secretaries of the national standardizing bodies, held at Zurich in July, 1923, the question of international standards was put forward by the Standard Commission of the Swedish

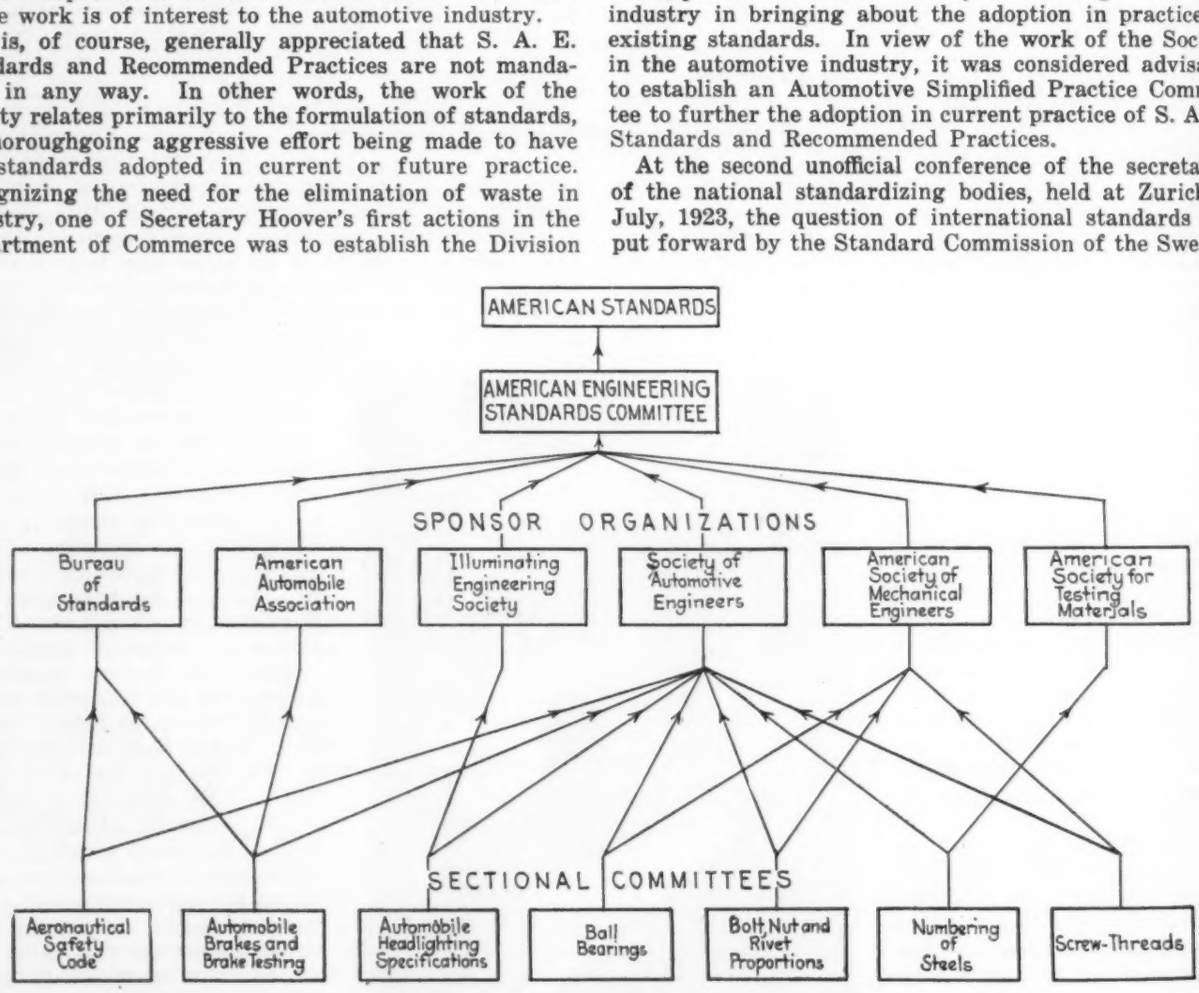
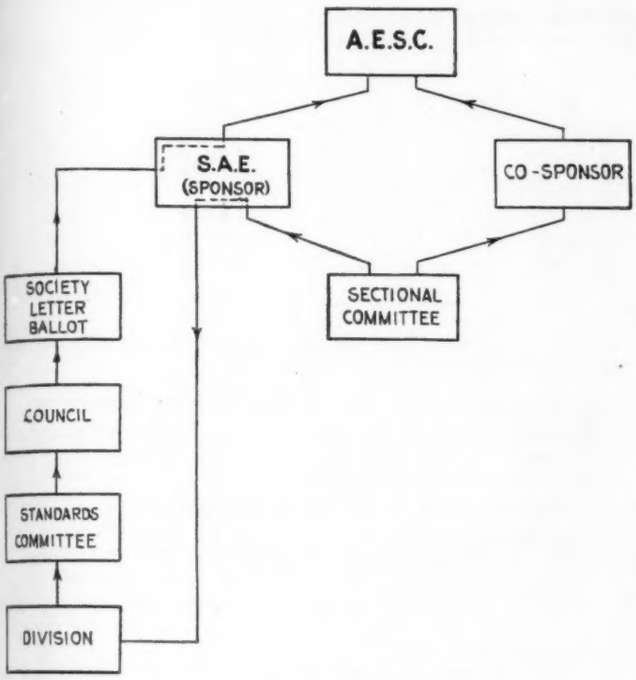


CHART SHOWING THE SECTIONAL COMMITTEES OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE OF WHICH THE SOCIETY IS A MEMBER AND THE OTHER SPONSOR ORGANIZATIONS ASSOCIATED WITH IT ON THEM

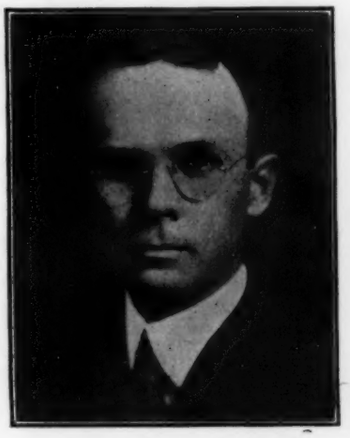


DIAGRAMMATIC OUTLINE OF PROCEDURE FOR ADOPTING AMERICAN STANDARDS

Machine Industries Association but lack of time prevented its discussion. Many countries besides the United States are developing national standards. International standards must, of course, be based upon national standards. At the present time no machinery for establishing International Standards exists but, through the American Engineering Standards Committee, agreement will probably be reached in the near future whereby the national ball-bearing standards of several European countries and of the United States will become practically identical, establishing to all intents and purposes an International Standard. The chances of success in establishing International Standards for ball bearings were, of course, most favorable in view of the fact that the S. A. E. Ball Bearing Standards originated in Germany, but it was necessary for both the American and the European Committees to compromise to a large extent to make international agreement possible.

C. M. MANLY.

PARTS AND FITTINGS DIVISION REPORT



CHAIRMAN W. C. KEYS

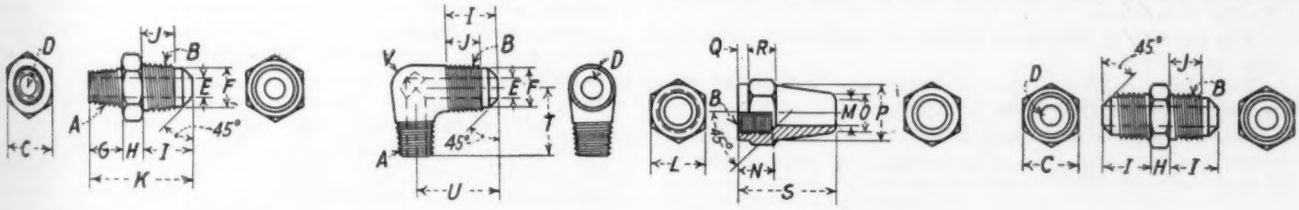
Since the special meeting of the Parts and Fittings Division held during the Annual Meeting in Detroit, at which the recommendation for compression-type couplings was revised, the Division has proposed revisions of the existing standards for flared-tube and soldered-type fittings, definite recommendations covering which were approved at the March Meeting of the Division. Recommendations covering bumper mountings and wire mesh were also approved at this meeting.

The standardization of Brake-Lining Specifications and Tests has been before the Division for several years. Clarence Carson, chairman of the Subdivision on Brake-Lining Specifications, has developed a new testing-machine that is thought to give better results than the machine originally developed by the Subdivision in cooperation with the Bureau of Standards. It is expected that a progress report will be submitted in the near future covering the results obtained to date.

A Subdivision has been appointed to investigate the possibilities of standardizing shock-absorber mountings. F. G. Whittington, of the Stewart-Warner Speedometer Corporation, is chairman of this Subdivision. Other subjects assigned to Subdivisions are tank and radiator caps, Woodruff keys and flexible-discs.

FLARED-TUBE TYPE FITTINGS

The Division has reviewed the present S. A. E. Standard for Flared-Tube Fittings, p. C46 of the S. A. E. HANDBOOK, and to bring it into conformity with the other tube-fitting standards and with current practice, has included the ⅛ and 3/16-in. sizes and has eliminated the ⅝ and ¾-in. sizes. The widths across flats of the hexagons have also been revised to bring them into accord with the proposed standard



Proposed Dimensions for Flared-Tube Fittings

Tubing Diam. ±0.002	A[1]	B[2]	C	D	E	F	G	H	I	J	K	L
1/8	1/8	5/16-24	7/16	5/64	7/64	15/64	3/8	5/32	5/16	1/4	27/32	*3/8
3/16	1/8	3/8-24	7/16	1/8	5/32	19/64	3/8	3/16	3/8	9/32	15/16	7/16
1/4	1/8	7/16-20	7/16	5/16	7/32	11/32	3/8	3/16	1/2	11/32	1 1/16	9/16
5/16	1/8	1/2-20	1/2	7/32	1/4	13/32	3/8	7/32	9/16	3/8	1 5/32	5/8
3/8	1/4	5/8-18	5/8	9/32	5/16	17/32	7/16	1/4	5/8	13/32	1 5/16	3/4
7/16	1/4	11/16-16	11/16	5/16	11/32	37/64	7/16	9/32	11/16	7/16	1 13/32	13/16
1/2	3/8	3/4-16	3/4	13/32	7/16	41/64	1/2	5/16	3/4	1/2	1 9/16	7/8

[1]American Standard taper pipe-threads.
[2]All threads shall be in accordance with the Fine-Thread Series, Free (Class 2) Fit.

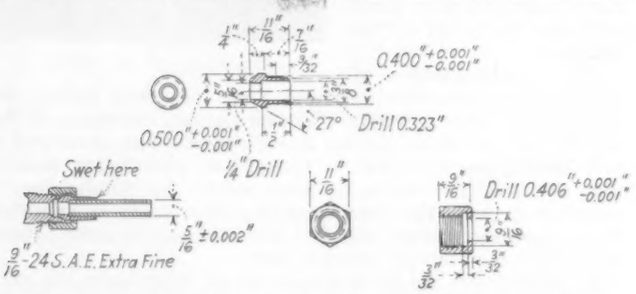
Proposed Dimensions for Flared-Tube Fittings (Continued)

Tubing Diam.	M Min.	M Max.	N	O	P	Q	R	S Long	S Short	T	U	V
1/8	0.130	0.135	7/32	1/4	3/8	3/32	1/8	3/4	1/2	11/16	5/8	1/16
3/16	0.192	0.197	9/32	5/16	7/16	3/32	3/16	15/16	5/8	3/4	3/4	3/32
1/4	0.255	0.260	11/32	3/8	9/16	1/8	1/4	15/16	3/4	3/4	7/8	1/8
5/16	0.317	0.322	3/8	7/16	5/8	1/8	5/16	1 1/8	7/8	3/4	15/16	1/4
3/8	0.380	0.385	7/16	1/2	3/4	1/8	3/8	1 5/16	1	7/8	1	9/32
7/16	0.442	0.447	1/2	9/16	13/16	1/8	7/16	1 1/2	1 1/16	15/16	1 1/8	5/16
1/2	0.505	0.510	9/16	5/8	7/8	1/8	1/2	1 5/8	1 1/8	1	1 3/16	11/32

for compression-type fittings. The present standard revised as proposed is given in the accompanying tables.

Soldered-Type Tube Fittings

In order that the dimensions for the present S. A. E. Standard for Soldered-Type Fittings, p. C47 of the S. A. E. Handbook, may conform as much as possible with the present standards for screw-thread tolerances and to make other minor revisions that are considered desirable, the Division



has proposed that the present recommended practice be revised to conform with the dimensions specified in the accompanying specifications.

The recommended practice revised as proposed, which has been referred to the members of the Truck and the Agricultural Power Equipment Divisions and to all motorcycle manufacturers, has met with general approval.

Proposed S. A. E. Recommended Practice for Soldered-Type Fittings

All fuel and lubrication tube fittings on motorcycles shall be of the soldered type.

These tolerances are the same as are specified for 24 threads per inch for the S. A. E. Fine-Thread Free (Class 2) Fit Tolerances.

The corners at both ends of the nut shall be chamfered 45 deg. to the flats.

The sleeve shall be made of brass and the nut of steel, nickel-plated over a coating of copper.

SCREW-THREAD TOLERANCES FOR FITTINGS AND NUTS

Diameter	Fitting Max.	Fitting Min.	Nut Max.	Nut Min.
Major	0.5625	0.5559	0.5625	.....
Pitch	0.5354	0.5321	0.5354	0.5387
Minor	0.5114	.....	0.5174	0.5219

Passenger-Car Bumper Mountings

As a result of a survey of the present practice of manufacturers including bumpers as regular equipment or designing frames to take bumpers readily, the Parts and Fittings Division has proposed revising the present standard for automobile bumper mountings, p. C55 of the S. A. E. Handbook, to specify 20 and 21 in. for the height of the front and rear bumpers respectively, instead of the present heights of 21 and 22 in. The present standard revised as proposed by the Division is given below.

Proposed S. A. E. Standard for Bumper Mountings

Protective bumpers for the front and the rear of passenger cars, small motorcoaches and light delivery-trucks shall conform to the following dimensions:

The horizontal center-line of the bumper face exclusive of fittings shall be 20 in., plus or minus ⅜ in. per inch of effective face, above the ground for front bumpers and 21 in., plus or minus ⅜ in. per inch of effective face, above the ground for rear bumpers.

The minimum over-all length of front and of rear bumpers shall be 59 in.

The minimum vertical depth of bars for single-bar type front and rear bumpers shall be 2 in.

The bumper height shall be measured with the car supplied with the normal amount of water, oil and gasoline, but without passengers or other load.

The vertical spread of a contact face shall be the distance between the upper and lower edges of the outer bumper elements, exclusive of any additional projecting parts.

If this recommendation is approved, the present standard for Passenger-Car Bumper Mountings, now printed on p. H24 of the S. A. E. Handbook, which specifies the proper punching for the front frame-horns, will be combined in the next issue of data sheets with the revised standard proposed above.

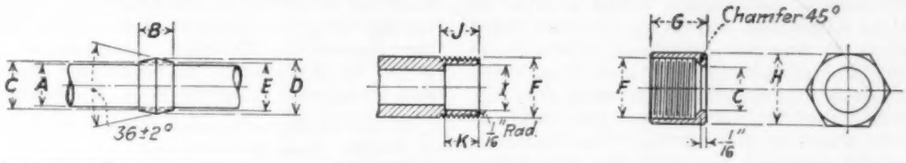
Compression-Type Tube Fittings

The Parts and Fittings Division has realized for some time that the present S. A. E. Recommended Practice for fuel and lubrication pipe-fittings of the flared-tube and the soldered types should be supplemented with compression-type fittings in view of the extent to which the last-named type is being used. Early in 1922 a Subdivision, consisting of W. H. Hollister, of the Imperial Brass Mfg. Co., who acted as chairman, and W. J. Outcalt, of the General Motors Corporation, was appointed. The first report of the Subdivision was published in the June, 1923, issue of The Journal.

The type of compression fitting proposed is made by several manufacturers with slight variations in the detailed dimensions. It was necessary to analyze the various dimensions used and decide upon such dimensions as would make it possible for the several manufacturers to adopt a standard without costly production changes.

A special meeting was held at Detroit in October, 1923, at which the Subdivision members met with representaives of the various compression-type fitting manufacturers and reviewed the original recommendation. The dimensions agreed upon at this meeting were submitted to the members of the Division at a meeting held the same day and met with approval. The revisions made in the original recommendation, taken individually, were of minor importance, but collectively they represented a careful refinement and correlation of corresponding dimensions for similar parts. As a result of printing the recommendation as then agreed upon in the December, 1923, issue of The Journal, a number of criticisms were received from car and truck builders. Also, the right of several pipe-fitting manufacturers to make and

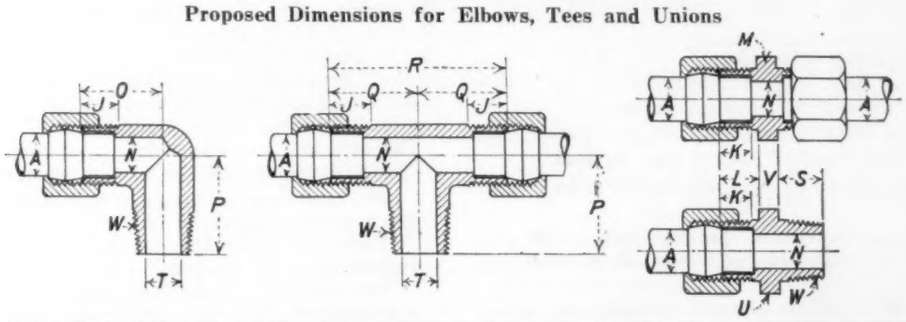
Proposed Dimensions for Sleeves, Nuts and Straight Threaded-Ends



Tubing Diameter *A* ±0.002	*B*	Sleeve Bore *C* ±0.002	Stock Diameter[1] *D*	Small Diameter of Taper *E*	*F*[2]	*G*	*H*	*I* ±0.002	*J* Minimum	*K*[3]
1/8	5/16	0.130	3/16	0.140	5/16–24	3/8	3/8	0.136	1/4	3/16
3/16	7/32	0.193	17/64	0.205	3/8–24	13/32	7/16	0.196	9/32	7/32
1/4	1/4	0.257	11/32	0.269	7/16–24	7/16	1/2	0.261	5/16	1/4
5/16	1/4	0.323	13/32	0.335	1/2–24	7/16	9/16	0.328	11/32	9/32
3/8	1/4	0.386	15/32	0.398	9/16–24	15/32	5/8	0.391	3/8	5/16
1/2	3/8	0.515	5/8	0.527	11/16–20	5/8	13/16	0.531	7/16	3/8

All dimensions in inches.
[1] A short flat will appear on the sleeves for the ¼, ⅜ and ⅝-in. sizes as a result of the stock diameters selected.
[2] All threads shall be in accordance with the Fine-Thread Series, Free (Class 2) Fit as given in the S.A.E. Standard for Screw-Threads.
[3] Also minimum usable length of threads on the double-end straight fitting.

Proposed Dimensions for Elbows, Tees and Unions



Tubing Diameter *A*	*L*	Diameter of Hexagon *M*	*N*	*O*	*P*	*Q*	*R*	*S*	*T*	Diameter of Hexagon *U*	*V*	*W*[1]
1/8	1/4	5/16	3/32	5/8	11/16	11/16	1 3/8	3/8	3/16	7/16	5/32	1/8
3/16	9/32	3/8	1/8	5/8	11/16	11/16	1 3/8	3/8	3/16	7/16	5/16	1/8
1/4	5/16	7/16	3/16	5/8	3/4	11/16	1 3/8	3/8	3/16	7/16	5/16	1/8
5/16	11/32	1/2	1/4	5/8	3/4	11/16	1 3/8	3/8	15/64	1/2	3/16	1/8
3/8	3/8	9/16	5/16	3/4	7/8	13/16	1 5/8	7/16	5/16	9/16	7/32	1/4
1/2	7/16	11/16	13/32	15/16	1 1/8	1	2	1/2	13/32	11/16	7/32	3/8

All dimensions in inches.
[1] American Standard Pipe Thread.
Both ends of the unions shall be chamfered 45 deg. to the flats.

market fittings in accordance with the proposed standard was questioned. Following the discussion at the special meeting, the Division's recommendation, which had been included in its report and printed in the January, 1924, issue of THE JOURNAL, was withheld in order that the industry might have an opportunity to comment on the revisions made at the meeting and to suggest any further revisions. The recommendation as revised at the January meeting has been submitted to fitting manufacturers and users and has apparently met with general approval.

As it is believed by some fitting manufacturers that certain features of the type of fitting covered by the proposed standard are controlled by patents owned by the Imperial Brass Mfg. Co., this company has submitted an offer to the Society to license any corporation or individual, specified by the Society, to manufacture, use and sell the type of fitting manufactured by it for a nominal consideration of $1. As such patent matters do not come within the scope of activity of the Society, the proposal to grant such a license has been transmitted to the National Automobile Chamber of Commerce. The recommendation proposed by the Division is therefore made with the proviso that the patent situation shall be cleared before the recommendation is acted upon by the Standards Committee.

WIRE-CLOTH

Since 1921 the Parts and Fittings Division has been developing a standard for wire mesh or cloth intended for oil, gasoline or water strainers. Because wire-cloth is not of great importance to the car builders, it is specified at the present time without due consideration of the makers' stock or manufacturing facilities. The specifications developed for adoption as S. A. E. Standard are based on information obtained from both manufacturers and users and have received wide publicity, both through general letters and by publication in THE JOURNAL, the report having been printed in the December, 1923, and the March, 1924, issues. Shipment of wire-cloth direct from the manufacturers' stock, quicker deliveries and an increase in the sources of supply should result from the adoption of this standard in future practice.

It has been suggested that the number of meshes might be reduced but, as differences of opinion are bound to occur as to what sizes should be eliminated and as all the sizes listed are now in production, it was not considered advisable to limit the list further. The diameter of the wire is specified in thousandths of an inch to obviate the confusion that has arisen owing to the fact that the different manufacturers of wire-cloth use various gages to indicate the wire diameter. The diameter tolerances proposed are such that the actual diameters used by the various manufacturers fall within the various diameter-ranges listed.

Proposed S. A. E. Standard for Wire-Cloth

Mesh	Diameter of Wire, In.	Size of Opening, In.	Proportion of Openings to Total Area, Per Cent[1]	Mesh	Diameter of Wire, In.	Size of Opening, In.	Proportion of Openings to Total Area, Per Cent[1]
8	0.028	0.097	60	45	0.0095	0.0130	34
10	0.025	0.075	56	50	0.009	0.0110	30
12	0.023	0.060	52	60	0.008	0.0090	29
14	0.020	0.051	51	70	0.007	0.0073	26
16	0.018	0.044	51	80	0.006	0.0068	29
20	0.016	0.034	46	90	0.005	0.0059	28
24	0.015	0.027	42	100	0.0045	0.0055	30
30	0.013	0.021	40	120	0.004	0.0043	26
35	0.011	0.018	40	150	0.003	0.0037	31
40	0.010	0.015	36	200	0.0021	0.0029	33

[1]This column is given for general information only.

Mesh denotes the number of openings per *inch*.

The weave shall be what is known as "Plain," except that in meshes 80 and finer, "twilled" weave may be used.

Double-crimped wire shall be used and woven so as to give square openings.

The accuracy of spacing wires shall be such as to give openings within 10 per cent, plus or minus, of the openings specified.

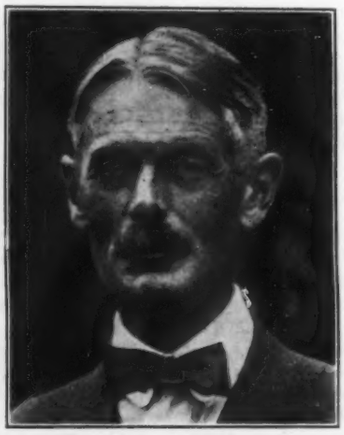
The variation in the diameter of the wire shall not exceed the following plus and minus tolerances:

	Inch
Up to and including 16 mesh	0.003
From 20 to 50 mesh	0.002
From 60 to 100 mesh	0.0015
Above 100 mesh	0.001

The material shall be specified by the purchaser, taking account of the fact that at present manufacturers of wire-cloth stock these meshes in steel and brass up to about 80 mesh; above this it is common practice to supply phosphor-bronze and monel-metal.

AERONAUTIC DIVISION REPORT

As Government specifications are followed in the production of aircraft purchased by the Government, and as this represents a large proportion of aircraft produced, no great necessity for the Aeronautic Division to take an active part in aeronautical standardization during the last few years has arisen. The standardization of structural aluminum alloy shapes was recently proposed, but a letter ballot of the Division members as to whether the Division should undertake such standardization indicated a consensus of opinion that it should not do so at this time.



CHAIRMAN H. M. CRANE

During 1917 and 1918 the Aeronautic Division developed a large number of standards that subsequently served as a basis for Government specifications. As many of the recommended practices adopted at that time have become obsolete, the Aeronautic Division recommends that the following S. A. E. Aeronautic Recommended Practices be cancelled and withdrawn from the S. A. E. HANDBOOK.

S. A. E. Recommended Practice	*Data Sheet*
Rubber Hose for Gasoline	C48
Ball Hexagon-Head Bolts and Nuts	C62
Bevel Washers	C64
Cellulose Acetate Dope	D131
Cellulose Nitrate Dope	D134
Spar Varnish	D136
Airplane Wheel Control	J6
Airplane Stick Control	J7
Marking of Pipe Lines	K43
Systems of Measurement	K43
Gaging of Sheet Metal, Rods, Tubes, Wires and Cables	K43

AIRPLANE BOLTS AND NUTS

The accompanying dimensions for aeronautic plain and castle hexagon-head bolts and nuts are proposed by the Aeronautic Division as a revision of the present S. A. E. Recommended Practices for plain hexagon-head bolts and nuts and castle hexagon nuts, pp. C59 and C60 of the S. A. E. HANDBOOK. The dimensions were developed by the Subdivision of which Edward Wallace, of the Glenn L. Martin Co., is chairman, the other members being George S. Case, of the Lamson & Sessions Co.; W. R. Mitchell, of the National-Acme Co.; E. H. Ehrman, of the Standard Screw Co.; and O. H. Hamm, of the Air Service.

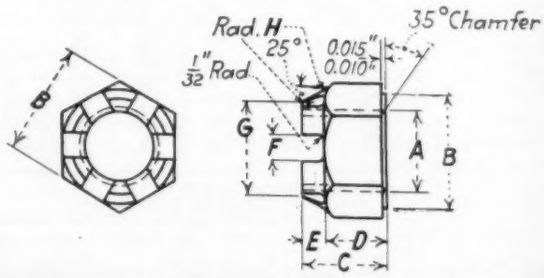
The bolt and nut dimensions proposed represent the following advantages over the present standards.

The cone shape distinguishes the aeronautic nut from the regular commercial nut.

The cone is a simple form to tool-up for and is lighter than the present form.

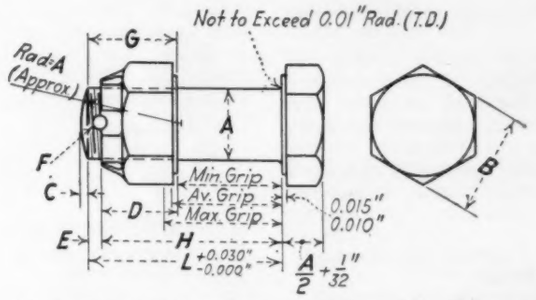
The wide slot allows free assembly of the cotter-pin, compensates for cotter-pin holes that are drilled a little off-center and permits the use of a stronger punch to shear the slot.

Proposed Dimensions for Aeronautic Castle Nuts



Bolt Diameter, Min. (A)		Threads per Inch	Pitch Diameter of Nut		Rated Strength, Lb.	B	C	D	E	F	G	H
Nom.	Dec.		Max.	Min.								
6	0.1380	40	0.1235	0.1218	900	5/16	7/16	1/8	3/16	1/16	0.220	1/16
8	0.1640	32	0.1456	0.1437	1200	5/16	15/64	5/32	7/64	1/16	0.245	1/16
10	0.1900	32	0.1716	0.1697	1800	5/16	7/16	5/32	7/64	5/64	0.270	1/16
12	0.2160	28	0.1950	0.1928	2400	5/16	17/64	5/32	7/64	5/64	0.295	1/16
1/4	0.2500	28	0.2290	0.2268	3400	7/16	19/64	5/32	7/64	3/32	0.330	1/16
5/16	0.3125	24	0.2878	0.2854	5400	1/2	23/64	15/64	1/8	3/32	0.400	1/16
3/8	0.3750	24	0.3503	0.3479	8100	9/16	27/64	9/32	9/64	3/32	0.445	1/16
7/16	0.4375	20	0.4076	0.4050	11000	11/16	31/64	21/64	5/32	5/32	0.540	1/16
1/2	0.5000	20	0.4701	0.4675	15000	3/4	35/64	3/8	11/64	11/64	0.600	1/16
9/16	0.5625	18	0.5294	0.5264	19000	7/8	39/64	27/64	3/16	3/16	0.660	1/16
5/8	0.6250	18	0.5919	0.5889	24000	15/16	43/64	15/32	13/64	13/64	0.725	1/16
3/4	0.7500	16	0.7126	0.7094	35000	1 1/16	25/32	9/16	7/32	1/4	0.870	1/16
7/8	0.8750	14	0.8322	0.8286	48000	1 1/4	1/8	21/32	7/32	5/16	1.040	1/16
1	1.0000	14	0.9572	0.9536	65000	1 7/16	1	3/4	1/4	1/4	1.200	1/16

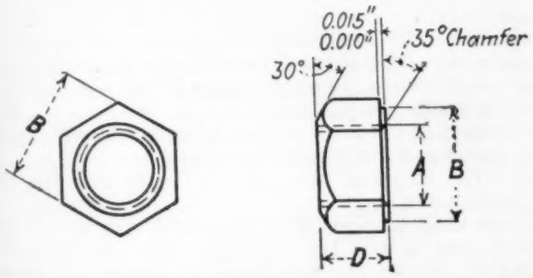
The greatest diameter of the chamfered part of the nut shall not exceed the major diameter.



Proposed Standard Dimensions for Aeronautic Hexagon Bolts

Nominal Size	Threads per Inch	Major Diameter (A) Max.	Major Diameter (A) Min.	Pitch Diameter Max.	Pitch Diameter Min.	Rated Strength, Lb.	B	C Max.	C Min.	D	E	Drill Size (F) No.	Drill Size (F) Dec.	Thread Length (G)	For L=1 In. H	For L=1 In. Grip Max.	For L=1 In. Grip Nom.	For L=1 In. Grip Min.
6	40	0.1380	0.1350	0.1218	0.1201	900	5/64	0.020	0.015	7/64	1/16	55	0.052	5/16	15/64	0.781	0.750	0.718
8	32	0.1640	0.1610	0.1437	0.1418	1200	5/64	0.025	0.020	15/64	1/16	55	0.052	19/64	15/64	0.766	0.735	0.703
10	32	0.1900	0.1870	0.1697	0.1678	1800	3/32	0.030	0.020	1/4	1/16	50	0.070	5/16	15/64	0.750	0.720	0.687
12	28	0.2160	0.2120	0.1928	0.1906	2400	3/32	0.035	0.025	17/64	5/64	50	0.070	11/32	29/64	0.734	0.695	0.656
1/4	28	0.2500	0.2460	0.2268	0.2246	3400	7/64	0.040	0.030	19/64	5/64	48	0.076	3/8	29/64	0.703	0.665	0.625
5/16	24	0.3125	0.3085	0.2854	0.2830	5400	1/8	0.045	0.030	25/64	5/64	44	0.086	7/16	33/64	0.641	0.605	0.565
3/8	24	0.3750	0.3710	0.3479	0.3455	8100	5/64	0.055	0.040	29/64	3/32	38	0.101	17/32	33/64	0.579	0.530	0.485
7/16	20	0.4375	0.4335	0.4051	0.4024	11000	11/64	0.065	0.050	33/64	3/32	36	0.107	19/32	37/64	0.516	0.470	0.422
1/2	20	0.5000	0.4960	0.4675	0.4649	15000	3/16	0.075	0.060	37/64	3/32	36	0.107	21/32	37/64	0.453	0.405	0.359
9/16	18	0.5625	0.5575	0.5264	0.5234	19000	7/64	0.085	0.070	29/32	1/16	30	0.129	23/32	41/64	0.391	0.337	0.282
5/8	18	0.6250	0.6200	0.5889	0.5859	24000	15/64	0.090	0.075	45/64	1/16	30	0.129	25/32	41/64	0.329	0.275	0.220
3/4	16	0.7500	0.7450	0.7094	0.7062	35000	17/64	0.105	0.090	27/32	1/16	28	0.141	15/16	1/2	0.219	0.155	0.094
7/8	14	0.8750	0.8700	0.8286	0.8250	48000	1 3/64	0.120	0.105	7/8	1/16	24	0.152	1 1/16	1/2	0.125	0.062	0.000
1	14	1.0000	0.9950	0.9536	0.9500	65000	1 1/16	0.140	0.125	1	1/16	24	0.152	1 1/16	1/2	0.000	−0.062	−0.125

Proposed Dimensions for Aeronautic Plain Nuts



Bolt Diameter, Min. (A) Nom.	Bolt Diameter, Min. (A) Dec.	Threads per Inch	Pitch Diameter of Nut Max.	Pitch Diameter of Nut Min.	Rated Strength, Lb.	B	D
6	0.1380	40	0.1235	0.1218	900	5/64	1/8
8	0.1640	32	0.1456	0.1437	1200	5/64	1/8
10	0.1900	32	0.1716	0.1697	1800	5/64	5/64
12	0.2160	28	0.1950	0.1928	2400	3/32	5/64
1/4	0.2500	28	0.2290	0.2268	3400	7/64	3/16
5/16	0.3125	24	0.2878	0.2854	5400	1/8	15/64
3/8	0.3750	24	0.3503	0.3479	8100	5/32	9/32
7/16	0.4375	20	0.4076	0.4050	11000	11/64	21/64
1/2	0.5000	20	0.4701	0.4675	15000	3/16	3/8
9/16	0.5625	18	0.5294	0.5264	19000	7/64	27/64
5/8	0.5250	18	0.5919	0.5889	24000	15/64	15/32
3/4	0.7500	16	0.7126	0.7094	35000	1 1/16	9/16
7/8	0.8750	14	0.8322	0.8286	48000	1 1/4	21/32
1	1.0000	14	0.9572	0.9536	65000	1 7/16	3/4

The end of the bolt is an arc with a definite radius.

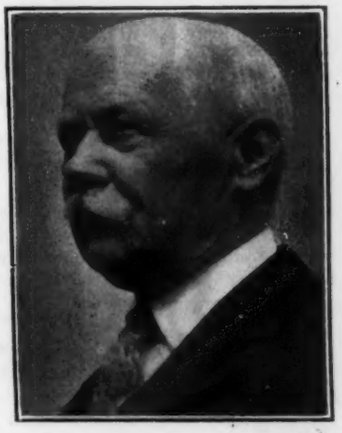
The bolt length is measured to the first thread.

The cotter-pin hole is located two threads from the first thread.

The length of the thread is equal to the thickness of the nut plus the length of two threads.

Although the proposed dimensions involve considerable change from the present standard dimensions, bolts and nuts made according to the proposed dimensions will be interchangeable with the present standard bolts and nuts.

AGRICULTURAL POWER EQUIPMENT DIVISION REPORT



Chairman J. F. Max Patiz

The April meeting of the Agricultural Power Equipment Division held in Chicago during the Society Tractor Meeting was the first held since early in 1923. At this meeting it was possible to take final action on all subjects awaiting Division consideration with the exception of Tractor Rating and Testing Forms, although O. W. Sjogren, of the University of Nebraska, submitted for discussion a draft of a simplified code for Tractor Rating based on the code adopted by the American Society of Agricultural Engineers. Several changes in the draft were suggested at the meeting. It is expected that the Division will be in a position to submit reports on this subject and on Testing Forms at the 1925 Annual Meeting.

Tractor Leather Driving Belts

The Agricultural Power Equipment Division has given very careful consideration to the development of proper specifications for tractor leather driving belts. A recommendation was submitted and approved at the January, 1924, Meeting of the Standards Committee, but withheld from publication owing to the fact that the test-specimen recommended did not agree with the test-specimen included in similar specifications adopted by the Federal Specifications Board.

As a result of subsequent Division consideration, it was decided that the test-specimen approved by the Federal Specifications Board was preferable to the one originally proposed

by the Division because the longer section would be more likely to give true average results.

There has also been a difference of opinion among the Division members as to the advisability of recognizing a specification for leather belts. It is believed, however, that leather belts are now available which will compare favorably with canvas and rubber driving belts.

The original specifications have been revised to specify a tolerance of plus 0 and minus 2 per cent instead of plus or minus 0.5 per cent for the length.

Proposed S. A. E. Recommended Practice for Tractor Leather Driving Belts

For farm tractors, new endless leather belts shall measure the full taped and specified length without allowance being made for the splice. This length shall be the single stock length and correct to within a tolerance of plus 0 and minus 2 per cent to take care of reasonable shrinkage or stretching and splicing in manufacture.

LENGTH OF LAPS IN INCHES

Ply	Thickness, In.	Belt Width, In.	Minimum Lap, In.
Single	19/64 and over	3	4
		4	4
		5	5
		6	6
Two-ply	15/64 and over	3, 6	3

The horsepower rating is for 16-oz. heavy-weight belts. For ratings of medium-weight belts, multiply by 0.9. The horsepower ratio of single to two-ply belts is 1.6.

The approximate horsepower rating is based on a belt speed of 3000 ft. per min. Belts shall be operated at one of the S. A. E. Standard belt speeds and at the above ratings. Belts are subject to a reasonable initial tension. The rating is such as will enable these belts to carry from 50 to 100-per cent overload according to weight as shown below over a reasonable period and during emergencies without injury.

Pulley Diameters

The driven pulley diameters shall be not less than 7 in. for light, 8½ in. for medium and 10 in. for heavy belts and should be preferably as large as practical conditions permit.

To insure good traction and long life, thinner and wider belts should be chosen in preference to thicker and narrower belts.

Specifications

Leather.—Belts under these specifications shall be made from vegetable-tanned belting butts only of standard tannages. They shall not be rolled. They shall be waterproof.

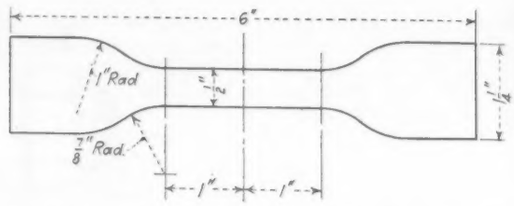
Currying.—The leather shall be properly curried. The grain surface shall be worked smooth but without rolling. The belt shall be dressed with a good waterproof dressing. The grease-content shall not exceed 25 per cent of the dry weight of the leather and shall not contain more than 35 per cent of unsaponifiable matter.

Adulteration.—Magnesium sulphate, glucose, barium chloride or any other materials shall not be used for weighting the leather. The presence of a greater amount of stuffing content than specified shall be considered as adulteration.

The belting shall be obtained from selected side-stock, and from within a distance of 24 in. from the backbone, thus excluding all belly and flank stock. No piece of leather in the finished belt shall be more than 56 in. in length.

Tensile-Strength.—Five samples taken from one belt or one lot of belts shall average 3300 lb. per sq. in. of cross-section, and the minimum shall be 3000 lb. per sq. in. The average shall be determined with five test-specimens selected at random from different parts of the sample being examined.

Test-specimens, as shown in the accompanying illustration, shall be cut with a metal die. The edges of the test-specimen



Test-Specimen Used in Making Tensile-Strength Tests

DIMENSIONS AND RATINGS OF LEATHER BELTS

Belt Width, In.	Belt Length, Ft. Plus 0 and Minus 2 Per Cent	Approximate Horsepower Rating	
		Single Ply	Double Ply
3	60, 75	15	24
4	60, 75	21	34
5	60, 75	25	40
6	60, 75	30	48

shall be cut at a true right-angle to the surface. The minimum thickness inside the gage-marks shall be used in determining the area of the cross-section of the test-specimen.

Stretching.—All leather after stuffing shall be thoroughly stretched while wet and left under tension until dry. All belt pieces shall have the stretcher-marks cut off.

The average elongation at a tensile stress of 2000 lb. per sq. in. shall not exceed 16 per cent. The average shall be determined with the same five test-specimens used for determining the tensile-strength, the data being taken at the same time.

To determine the amount of elongation parallel gage-marks 2 in. apart shall be placed under the restricted portion of the test-specimens. The distance between the gage-marks shall be measured with a pair of spring-dividers, at a tensile stress of 2000 lb. per sq. in.

The amount of stretch shall then be determined by measuring the opening of the dividers on a scale.

Laps.—The length of laps shall be made with the limits given in the table.

The laps shall not open when subjected to a tensile stress of 2000 lb. per sq. in. The opening of the laps shall be determined by testing two specimens cut across the point of the lap lengthwise of the sample. The laps are to be carefully cemented with waterproof cement and may be tested by immersion in water for 24 hr.

Weight and Thickness.—The thickness for the different grades of belting shall be as specified in the accompanying table.

AVERAGE THICKNESS OF DIFFERENT GRADES

Grade	Weight, Oz.	Average Thickness, In.
Medium single-ply	14	19/64 up to 13/64
Heavy single-ply	16	12/64 up to 14/64
Medium two-ply	21	16/64 and over

The average thickness shall be determined by measuring the thickness of 15 to 20 plies of the belt when rolled, and dividing this value by the number of plies measured.

Uniformity.—No point in any belt shall be more than 2/64 in. thicker, nor more than 2/64 in. thinner, than the average thickness.

Tolerances.—Belts shall not vary from nominal width more than 2½ per cent.

Tractor Speeds

In 1917 when the standard plowing speed of 2 1/3 m.p.h. for tractors of 15 drawbar hp. and under was adopted, the

farm tractor was primarily a plowing implement. It is now used for operating many different farm implements as well as for industrial purposes, such as around plants, yards or in hauling material. The Agricultural Power Equipment Division therefore recommends that the present standard be revised to read:

> The normal tractor speeds, when measured on the driving wheels or by an equivalent method, shall be 2¼, 3, 4 and (or) 10 m.p.h.

The speeds of 2¼ and 4 m.p.h. were included in the recommendation to cover special types of tractor.

Tractor Specifications

With reference to the Tractor Specifications printed on pp.K34 to K39 inclusive of the S. A. E. Handbook, the Agricultural Power Equipment Division believes they have served the purpose for which they were developd in 1919 and rcommends that they be cancelled.

Tractor Power Take-Off Speed

At the meeting of the Agricultural Power Equipment Division in April, the following recommendation was approved:

> The normal speed of the power take-off of tractors designed for operating tractor-propelled agricultural implements shall be 536 r.p.m., the rotation to be clockwise when looking in the direction in which the tractor travels.

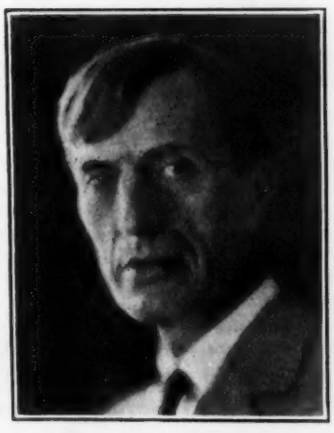
This recommendation was approved in view of the fact that the power take-off speed used throughout the industry has been practically constant for 30 years, this being determined by the speed of the sickles. It is believed to be advisable, however, to recognize this standard speed for the future guidance of tractor and implement designers. The Division therefore submits the proposal for adoption as S. A. E. Recommended Practice.

Tractor Canvas and Rubber Driving Belts

In July, 1923, the Division recommendation for canvas and rubber driving belts was adopted as S. A. E. Recommended Practice. Since the adoption of this specification, the following two changes have become necessary and the Division recommends that the present specification be revised to conform therewith:

> The tolerances for the length shall be plus 0 minus 2 per cent, not plus or minus 0.25 per cent.
>
> The length per linear yard 36 in. wide shall be not less than 28, instead of 32, oz.

BALL AND ROLLER BEARINGS DIVISION REPORT



Chairman F. W. Gurney

Since the time of the organization of the American Sectional Committee on Ball Bearings, the Ball and Roller Bearings Division of the Society has given considerable attention to the matter of the feasibility of revising existing S. A. E. Standards so as to make complete international agreement possible. The work with the Sectional Committee in this connection has been of an informal nature, as it was desired to determine what compromises could be effected between European and American practice before committing the sponsors to definite recommendations. At meetings of the Sectional Committee and of the Division in April, definite agreement was reached as to American practice for light, medium and heavy single-row annular ball bearings, including what are known as the extended series or large sizes. The revisions of the S. A. E. Standards, involved in the American practice, approved by the Division do not affect the sizes most widely used in the industry, but only the larger sizes produced in relatively small numbers.

In addition to this work, the Division is considering the adoption of a medium-heavy series of ball bearings, F. W. Gurney being chairman of a Subdivision assigned this work. D. F. Chambers is chairman of a Subdivision charged with revising the present S. A. E. Standard thrust ball-bearings to conform with standards proposed for adoption as International Standards.

Wide-Type Annular Ball-Bearings

Early in 1921 F. G. Hughes, of the New Departure Mfg. Co., was appointed a committee of one to investigate the suitability of the present widths for the smaller-size wide-type annular ball-bearings. The work involved considerable research and many tests, and it was impossible to submit a definite report until early this year. The report submitted was approved at the May 2 meeting of the Division. The following summarizes the reasons for the changes proposed:

> The narrow widths do not allow sufficient center-to-center distance between the two rows of balls to accommodate a separator of sufficient strength; that is, the space between the two rows of balls does not allow sufficient thickness of material, considering that it is absolutely necessary that the two rows be controlled by separators entirely independent of each other.
>
> In some sizes the widths do not allow a race section that is capable of withstanding the loads that the balls are capable of sustaining and, therefore, it is impossible to obtain the maximum carrying-capacity of the bearings.
>
> In some cases the increase in race section allows an increase in the ball diameter, thereby increasing the carrying capacity of the bearings.

The Ball and Roller Bearings Division therefore recommends that the present S. A. E. Standard for Wide-type Annular Ball-Bearings, p. C31 of the S. A. E. Handbook, be revised as indicated in the accompanying tabulation

Bearing No.	Present Width	Proposed New Width
200	½	9/16
201	½	5/8
202	½	5/8
203	½	11/16
204	¾	13/16
205	¾	13/16

LIGHTING DIVISION REPORT

Chairman C. A. Michel

The 1924 Lighting Division has given considerable time and study to the present lighting-equipment standards as a result of the pressure that has been brought to bear on the passenger-car builders by the legal requirements adopted by various States. A joint meeting of the Lighting Committee of the Eastern Conference of Motor-Vehicle Administrators and the members of the Lighting Division was held at New York City in March, the object being primarily to determine how the committees could cooperate to the greatest advantage in developing proper standards for automobile lighting equipment. At this meeting A. W. Devine, motor-vehicle administrator of Massachusetts and chairman of the Lighting Committee of the Eastern Conference of Motor Vehicle Administrators, stated that the

greatest difficulty the administrators experience is the indifference of the car-owners to keeping their head-lamps in good mchanical condition and in proper adjustment; for readjustment of present equipment is necessary every 2 or 3 weeks.

He emphasized the fact that the reason for this condition is, in many cases, poor material and workmanship, the greatest troubles being due to misformed reflectors, sagging and misplaced lamp-filaments and loose lamp-sockets. It was his opinion that if the car-builders would not use such standards as were formulated to meet the engineering and legal requirements, laws would be enacted by several States that would require the inspection and the approval of the entire car-lighting equipment. It was the feeling of the Lighting Division members that this condition was the result of the car-builders demanding the lowest-price lighting equipment obtainable without regard to whether it would stand up in normal service.

As a result of the joint meeting, the various lighting-equipment standards now printed in the S. A. E. HANDBOOK were assigned to Subdivisions for review and recommendation as to revision necessary to bring them into accord with desirable lighting practice. The reports of the Subdivisions were acted upon at a meeting in Detroit in April, the Subdivision recommendations having been previously submitted to the principal passenger-car builders for comment, with the special request that those interested meet in Detroit with the members of the Lighting Division.

PASSENGER-CAR HEAD-LAMPS

The sections of the present S. A. E. Recommended Practice for Head-Lamps covering mountings and brackets were referred to a Subdivision under the chairmanship of A. R. Lewellen, of the Chevrolet Motor Co., the other members being G. P. Doll, of the Thomas J. Corcoran Lamp Co.; H. H. Oetjen, of Edmunds & Jones Corporation; C. C. Salisbury, of the Hupp Motor Car Corporation; W. W. Mathews, of the Pennsylvania Highway Department; and C. H. Williams, of the Studebaker Corporation of America. The present specifications as revised by the Subdivision and approved by the Division are given in the accompanying revised specifications for Passenger-Car Head-Lamps.

It was recognized by the Division that the type of focusing mechanism used has an extremely important bearing on legislation, as the enforcement of head-lamp illumination laws could be greatly simplified if a standard could be adopted requiring that all head-lamps should be focused from the exterior. A Subdivision was therefore appointed to consider this subject, consisting of C. A. Michel, chairman; E. S. Preston, of the Chicago Electric Mfg. Co.; C. A. B. Holvorson, Jr., of the General Electric Co.; R. N. Falge, of the National Lamp Works; and C. E. Godley, of Edmunds & Jones Corporation.

The report submitted by the Subdivision was approved by the Division at the April Meeting, and is included in the following complete recommendation for Passenger-Car Head-Lamps revised as proposed by the Lighting Division.

Revised S. A. E. Recommended Practice for Head-Lamp Mountings

All motor-vehicle head-lamps shall be adjustable vertically and horizontally and mounted so that their centers are not less than 32 in. nor more than 42 in. from the ground, the preferred height being 36 in. The horizontal adjustment shall be such that the axis of the light beam will be brought parallel to the center-line of the car and the vertical adjustment such as to permit tilting the projected main beam to an angle of not less than 6 deg. below a plane parallel with the road surface. All types of head-lamp mountings or brackets shall comply with these mounting specifications, adjustments being made by a ½-in.-20 S. A. E. Standard nut in an accessible position.

Universal Type.—It is recommended that the universal adjustable type of mounting as shown on p. B1a of the S. A. E. HANDBOOK be used with all types of mounting brackets.

Fender Type.—The fender-type head-lamp bracket shall be attached to the outside of the lamp body and the bolt-holes in the lamp bracket shall be of 13/32-in. diameter on centers 3 in. apart. The mounting surface of the fender bracket shall be parallel to the axis of the lamp.

Hollow-Prop Type.—The shank of the hollow-prop type of head-lamp bracket shall be 1-1/16 in. in diameter and 2 in. long.

Fork Type.—The fork-type head-lamp bracket shall have center-to-center widths of 6, 7¼, 8¼ or 9¼ in. The upper ends of the fork shall be ½ in. in diameter with a ½-in.-20 S. A. E. Standard thread. Shoulders shall be machined to not less than ¾ in. in diameter. The distance from the upper face of the shoulder to the last full thread on the ends of the fork shall be not less than 1½ in. where no tie-rod is used or 1½ in. plus the thickness of the rod where a tie-rod is used. The use of nuts and lock-washers for locking lamps to the fork is recommended.

The lugs attached to the lamp housing shall have bores of 17/32-in. diameter and 1½ in. long. The center-line of the holes in the lugs shall be not less than 9/16 in. from the nearest point of the lamp housing. The clearance between the lower part of the bracket and the lamp housing shall be not less than 9/16 in.

REFLECTORS[1]

The reflectors shall be made as nearly as possible in the form of a true paraboloid of revolution having a fixed focal length of 1¼ in.

The reflector should be located in the head-lamp housing in such a manner as will allow no distortion of the reflector when any adjustment is required. A suitable sealing method should be used to exclude dust from the polished reflector surface.

FOCUSING MECHANISM AND SOCKET[1]

Where focusing adjustment mechanisms are used, the mechanism shall be constructed so as to permit the focusing adjustment to be made outside of the lamp body, or the mechanism shall be mounted on the back of the reflector in such a manner as to be readily accessible without the removal of the lens.

Focusing mechanisms shall be constructed of non-corroding materials to permit making adjustments freely at all times.

For alignment and stability purposes, where focusing mechanisms permit of adjustment only along, or parallel to, the axis of the electric incandescent lamp, the use of a reflector sleeve shall be employed having

An inside diameter of from 0.692 in. minimum to 0.696 in. maximum.

Sufficient length to permit the socket to be keyed against rotation throughout the total length of adjustment.

A friction device that will eliminate the play between the socket and the reflector sleeve throughout the total length of adjustment.

Focusing mechanisms shall permit a minimum adjustment of the filament of 5/32 in. forward and 5/32 in. backward of the focal point of the reflector with an incandescent lamp having the standard light-center length of 1¼ in.

Means shall be provided to prevent the focusing screw from backing out.

Focusing mechanisms shall be constructed so as to maintain the relative position of the reflector and the electric incandescent lamp when the door or lens is removed.

ELECTRIC INCANDESCENT LAMPS

It has been recognized for some time that road illumination could be controlled to greater advantage if the light source were held to closer limits. Lamp manufacture has, as a result of recent developments, improved to such a point that it is possible to maintain lamp filaments within about one-half the present limits. The subject was therefore referred to the Subdivision on Focusing Mechanisms, of which

[1] S.A.E. Standard.

C. A. Michel was chairman. At the Subdivision meeting held on April 8 the following recommendation was agreed upon, and was subsequently approved by the Lighting Division. The Division therefore recommends that the present S. A. E. Standard for Electric Incandescent Lamps, p. B3 of the S. A. E. HANDBOOK, be revised to specify that

> The light-center length for all focusing-type electric incandescent lamps used in head-lamps for either electric or gasoline-propelled vehicles shall be 1¼ in. plus or minus 3/64 in. as measured from the center of the filament field to the bulb side of the lock-pins in the base. [This is now specified as 1¼ plus or minus 3/32 in.]
>
> The longitudinal axis of the lamp filament at the focal point shall not deviate more than 3/64 in. from the axis of the lamp base. [This is now specified as 5/64 in.]

The Subdivision is giving consideration at the present time to placing limits on the angular position on the base-pins with relation to the plane of the filament. As it is felt that further work must be undertaken by the manufacturers before a definite specification can be approved or developed for these limits, the Subdivision is giving this matter further study.

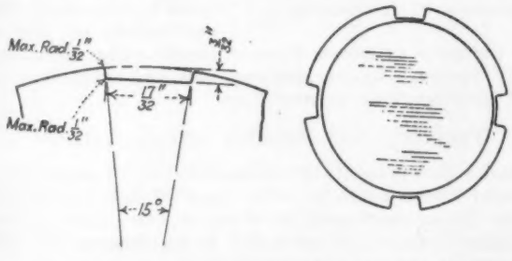
LAMP GLASSES

The present S. A. E. Standard for Lamp Glasses, p. B6 of the S. A. E. HANDBOOK, specifies the use of straight notches to keep the glass from turning in the lamp As a result of criticisms submitted by lamp-glass manufacturers as to the shape of this notch, a Subdivision consisting of C. E. Godley, of the Edmunds & Jones Corporation, and E. Y. Davidson, Jr., of the Macbeth-Evans Glass Co., was appointed to study the matter and to recommend, if possible, a better design of notch. A report was submitted to the Division in the latter part of 1923 and referred to the manufacturers of head-lamps and head-lamp glasses for comment. The consensus of opinion as determined by this general letter indicated a decided preference for tapered notches as proposed by the Subdivision. At the March meeting of the Lighting Division the Subdivision report was reviewed and met with general approval. The Lighting Division, therefore, recommends that the present standard be revised to specify the method of notching illustrated in the accompanying specifications.

The Division has also made a survey of the present practice of spot-lamp manufacturers with regard to lens diameters used, and finds it desirable to specify the two diameters of 4½ and 6 in. rather than the single diameter of 6 in. now specified. It also recommends a definite head-lamp glass diameter for motorcycles as present practice is now practically uniform.

The present standard for Lamp Glasses revised as proposed by the Subdivision is printed hereinafter.

Proposed Revised S. A. E. Standard for Lamp Glasses



HEAD-LAMP GLASS AND PRISM-AREA DIAMETERS

Outside Diameter ±1/32	Diameter of Prism Area ±1/32
8 5/32	6 7/8
8½	7¼
9	7¾
9½	8¼

This standard applies only to automobile electric and oil-lamp glasses. The thickness of the bevel edge for all sizes of head-lamp glass shall be 5/32 in. at the edge of the prism area and ⅛ in. at the edge of the glass, with tolerances of plus 1/64 in. and minus 0. This is commonly known as double-thick American glass.

Four locking notches, as specified in the drawing, shall be used in other than plain head-lamp glasses.

MOTORCYCLE HEAD-LAMP GLASSES

Motorcycle head-lamp glasses shall have a 6⅛-in. outside diameter. The diameter of their prism area shall be 5⅜ in. The tolerances for these diameters shall be plus and minus 1/32 in. The thickness of the bevel edge for all sizes of head-lamp glass shall be 5/32 in. at the edge of the prism area and ⅛ in. at the edge of the glass, with tolerances of plus 1/64 in. and minus 0.

Four locking notches, as specified in the drawing, shall be used in other than plain head-lamp glasses.

SIDE-LAMP GLASS DIAMETERS AND LIGHT OPENINGS

Outside Diameter		Minimum Light Opening in Door	
Nominal	Tolerances	Nominal	Tolerances
2	+0,—1/32	1⅝	+0,—1/32
2½	+0,—1/32	2⅛	+0,—1/32
3	+0,—1/32	2½	+0,—1/32
5	±1/32	4	±1/32
6	±1/32	5	±1/32
7	±1/32	6	±1/32

TAIL-LAMP GLASS DIAMETER

The glass diameter used for tail-lamps shall be 3 in., with tolerances of plus 0 and minus 1/32 in.

SPOT-LAMP GLASS DIAMETERS

The glass diameters used for spot-lamp glasses shall be 4½ and 6 in., with tolerances of plus and minus 1/32 in. The minimum light-openings in the lamp door shall be 3½ and 5 in. respectively, with tolerances of plus and minus 1/32 in.

BASES, SOCKETS AND CONNECTORS

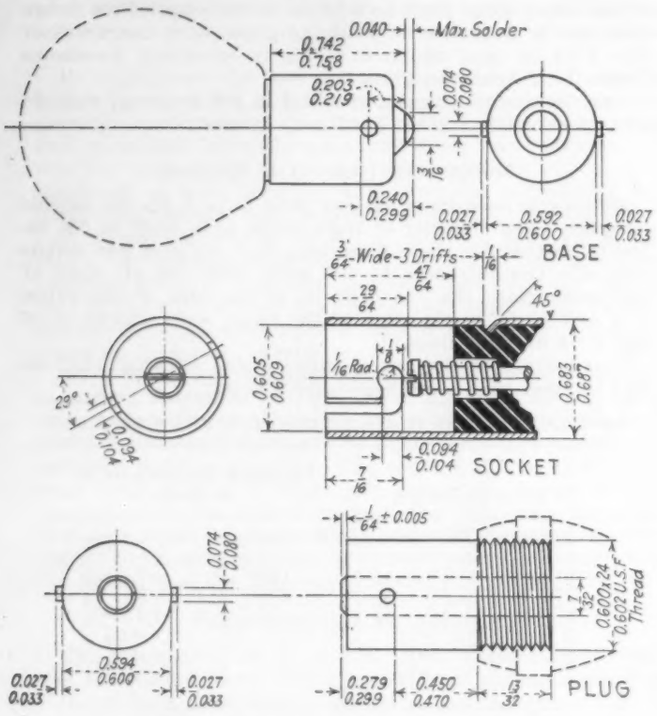
As the present standard for Bases, Sockets and Connectors had been criticised to the effect that they did not stand up in normal passenger-car service, a Subdivision was appointed in 1923 to consider what changes were necessary to meet desirable practice. Charles E. Godley, of the Edmunds & Jones Corporation, was appointed chairman of a Subdivision, the complete personnel being:

C. E. Godley, *Chairman*	Edmunds & Jones Corporation
A. K. Brumbaugh	Autocar Co.
J. T. Caldwell	National Lamp Works
C. A. Michel	Guide Motor Lamp Co.
E. S. Preston	Chicago Electric Mfg. Co.
A. J. Scaife	White Motor Co.
J. C. Stearns	Culver-Stearns Mfg. Co.
F. W. Todd	Accessories Mfg. Co.
T. I. Walker	Providence Base Works
Ernest Wooler	Cleveland Automobile Co.

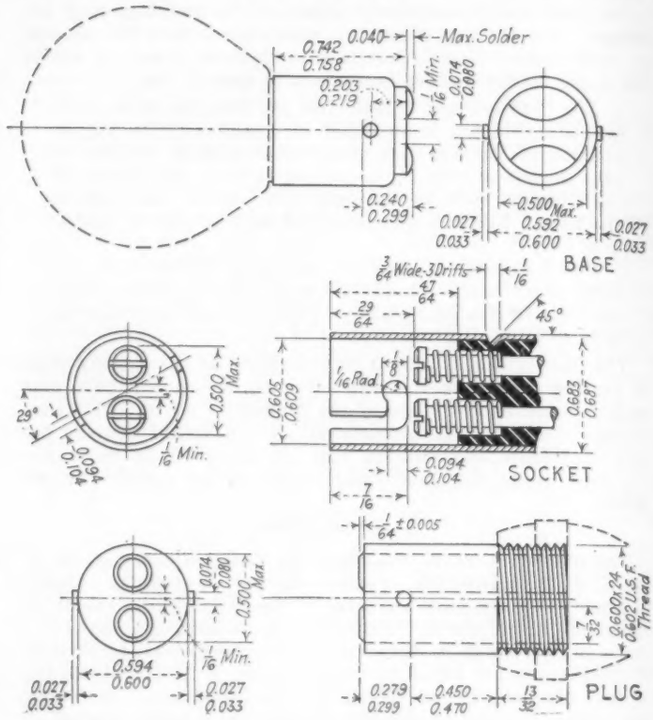
As a result of several meetings the Subdivision proposed many changes in the present standards, the principal ones being:

> Gage dimensions for checking the alignment of pins and slots and the maximum outside and the minimum inside diameters of bases, plugs and sockets were included.
>
> Minimum dimensions from the pin-seat to the top of the solder on the base were specified.
>
> The type of plunger in the socket was changed from an internal to an external spring.

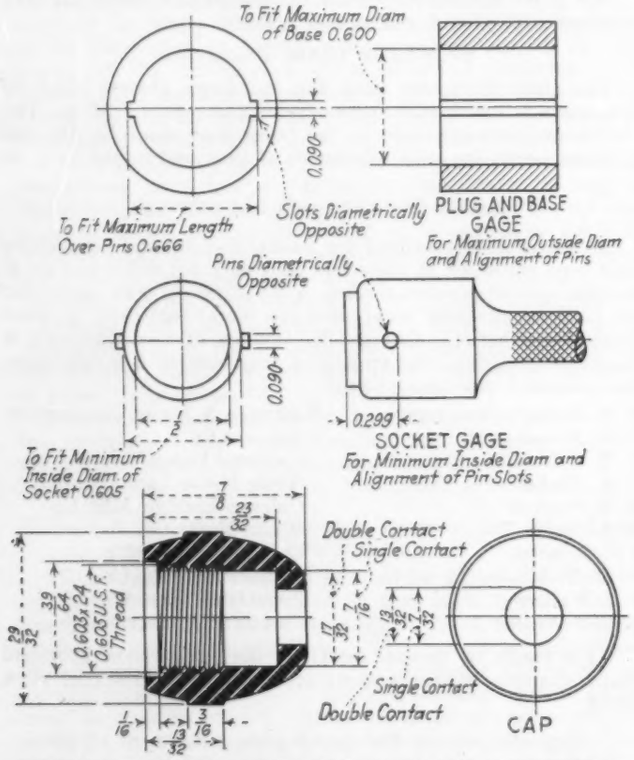
Proposed S. A. E. Standard Single-Contact Bases, Sockets and Plugs



Proposed S. A. E. Standard for Double-Contact Bases, Sockets and Plugs



Proposed S. A. E. Standard for Gages and Plug Caps



Owing to a difference of opinion as to whether double or single-contact base lamps should be used, and to a general feeling that the subject warrants further study, the Subdivision has not been able to report definite recommendations for heavy-duty plugs and sockets for motor-truck service at this time. It plans to make up sample connectors, however, and try them out in actual service in order that future action may be based on definite information.

NON-FERROUS METALS DIVISION REPORT

CHAIRMAN W. R. WEBSTER

The work before the Non-Ferrous Metals Division during the last year has not warranted holding a Division meeting, but several changes in, and extensions of, the existing specifications have been considered and acted upon by letter ballot. These recommendations complete all of the work in progress and it is believed that the present non-ferrous metals specifications printed on pp. D101 to D125 inclusive of the S. A. E. HANDBOOK, revised and extended as proposed hereinafter, will meet the requirements of the automotive industry as to non-ferrous metals. The Division will be ready, however, to consider revisions and extensions of the present specifications at any time.

WROUGHT NON-FERROUS METAL ALLOYS

To make the present specifications for wrought non-ferrous metal alloys conform with those of the United States Ordnance Department and the Federal Specifications Board, the Division considers it advisable to recommend the following changes in the present specifications:

Specification No. 69, *Wrought Aluminum Bronze.*—The elongation specified should be changed to read: 20, 25 and 30 per cent instead of 30, 28 and 25 per cent. The tolerances for the permissible thickness variations as given in Table 1 should be included.

Specification No. 70, *Commercial Brass Sheet.*—The thickness tolerances specified should be revised to conform to those specified in Table 2.

Specification No. 71, *Copper Sheet.*—The thickness

TABLE 1—PERMISSIBLE VARIATIONS IN THICKNESS OF SHEETS AND STRIPS

Thickness		Up to 6 In. Wide, Inclusive	Over 6 to 9 In. Wide, Inclusive	Over 9 to 14 In. Wide, Inclusive	Over 14 to 20 In. Wide, Inclusive
B. & S. Gage No.	In.				
0000	0.4600	0.0054	0.0056	0.0059	0.0061
000	0.4096	0.0053	0.0055	0.0058	0.0060
00	0.3648	0.0051	0.0054	0.0056	0.0059
0	0.3249	0.0050	0.0053	0.0055	0.0058
1	0.2893	0.0049	0.0051	0.0054	0.0056
2	0.2576	0.0048	0.0050	0.0053	0.0055
3	0.2294	0.0046	0.0049	0.0051	0.0054
4	0.2043	0.0045	0.0048	0.0050	0.0053
5	0.1819	0.0044	0.0046	0.0049	0.0051
6	0.1620	0.0043	0.0045	0.0048	0.0050
7	0.1443	0.0041	0.0044	0.0046	0.0049
8	0.1285	0.0040	0.0043	0.0045	0.0048
9	0.1144	0.0039	0.0041	0.0044	0.0046
10	0.1019	0.0038	0.0040	0.0043	0.0045
11	0.0907	0.0036	0.0039	0.0041	0.0044
12	0.0808	0.0035	0.0038	0.0040	0.0043
13	0.0719	0.0034	0.0036	0.0039	0.0041
14	0.0640	0.0033	0.0035	0.0038	0.0040
15	0.0570	0.0031	0.0034	0.0036	0.0039
16	0.0508	0.0030	0.0033	0.0035	0.0038
17	0.0452	0.0029	0.0031	0.0034	0.0036
18	0.0403	0.0028	0.0030	0.0033	0.0035
19	0.0359	0.0026	0.0029	0.0031	0.0033
20	0.0320	0.0025	0.0026	0.0029	0.0030
21	0.0284	0.0024	0.0025	0.0026	0.0028
22	0.0253	0.0023	0.0024	0.0025	0.0026
23	0.0225	0.0021	0.0023	0.0024	0.0025
24	0.0201	0.0020	0.0021	0.0023	0.0024
25	0.0179	0.0019	0.0020	0.0021	0.0023
26	0.0159	0.0018	0.0019	0.0020	0.0021
27	0.0142	0.0016	0.0018	0.0019	0.0020
28	0.0126	0.0015	0.0016	0.0018	0.0019
29	0.0112	0.0014	0.0015	0.0016	0.0018
30	0.0100	0.0014	0.0015	0.0016	0.0018
31	0.0089	0.0013	0.0014	0.0015	0.0016
32	0.0079	0.0013	0.0014	0.0015	0.0016
33	0.0070	0.0011	0.0013	0.0014	0.0015
34	0.0063	0.0011	0.0013	0.0014	0.0015
35	0.0056	0.0010	0.0011	0.0013	0.0014
36	0.0050	0.0010	0.0011	0.0013	0.0014

All dimensions in inches. All tolerances plus and minus.

TABLE 2—PERMISSIBLE VARIATIONS IN THICKNESS OF SHEETS AND STRIPS

Thickness		Up to 6 In. Wide, Inclusive	Over 6 to 9 In. Wide, Inclusive	Over 9 to 14 In. Wide, Inclusive	Over 14 to 20 In. Wide, Inclusive
B. & S. Gage No.	In.				
0000	0.4600	0.0043	0.0045	0.0047	0.0049
000	0.4096	0.0042	0.0044	0.0046	0.0048
00	0.3648	0.0041	0.0043	0.0045	0.0047
0	0.3249	0.0040	0.0042	0.0044	0.0046
1	0.2893	0.0039	0.0041	0.0043	0.0045
2	0.2576	0.0038	0.0040	0.0042	0.0044
3	0.2294	0.0037	0.0039	0.0041	0.0043
4	0.2043	0.0036	0.0038	0.0040	0.0042
5	0.1819	0.0035	0.0037	0.0039	0.0041
6	0.1620	0.0034	0.0036	0.0038	0.0040
7	0.1443	0.0033	0.0035	0.0037	0.0039
8	0.1285	0.0032	0.0034	0.0036	0.0038
9	0.1144	0.0031	0.0033	0.0035	0.0037
10	0.1019	0.0030	0.0032	0.0034	0.0036
11	0.0907	0.0029	0.0031	0.0033	0.0035
12	0.0808	0.0028	0.0030	0.0032	0.0034
13	0.0719	0.0027	0.0029	0.0031	0.0033
14	0.0640	0.0026	0.0028	0.0030	0.0032
15	0.0570	0.0025	0.0027	0.0029	0.0031
16	0.0508	0.0024	0.0026	0.0028	0.0030
17	0.0452	0.0023	0.0025	0.0027	0.0029
18	0.0403	0.0022	0.0024	0.0026	0.0028
19	0.0359	0.0021	0.0023	0.0025	0.0026
20	0.0320	0.0020	0.0021	0.0023	0.0024
21	0.0284	0.0019	0.0020	0.0021	0.0022
22	0.0253	0.0018	0.0019	0.0020	0.0021
23	0.0225	0.0017	0.0018	0.0019	0.0020
24	0.0201	0.0016	0.0017	0.0018	0.0019
25	0.0179	0.0015	0.0016	0.0017	0.0018
26	0.0159	0.0014	0.0015	0.0016	0.0017
27	0.0142	0.0013	0.0014	0.0015	0.0016
28	0.0126	0.0012	0.0013	0.0014	0.0015
29	0.0112	0.0011	0.0012	0.0013	0.0014
30	0.0100	0.0011	0.0012	0.0013	0.0014
31	0.0089	0.0010	0.0011	0.0012	0.0013
32	0.0079	0.0010	0.0011	0.0012	0.0013
33	0.0070	0.0009	0.0010	0.0011	0.0012
34	0.0063	0.0009	0.0010	0.0011	0.0012
35	0.0056	0.0008	0.0009	0.0010	0.0011
36	0.0050	0.0008	0.0009	0.0010	0.0011

All dimensions in inches. All tolerances plus and minus.

tolerances specified should be revised to conform to those specified in Table 2.

Specification No. 77, Phosphor-Bronze Strip.—The thickness tolerances specified should be revised to conform to those specified in Table 1.

At the Standards Committee Meeting held in June, 1922, the specifications proposed for Soft or Annealed Copper Wire were referred back to the Division pending the final report of the Subdivision on Magnet Wire. These specifications have recently been approved by the Subdivision and are, therefore, resubmitted for approval as S. A. E. Standard. The specifications, which are given below, are abstracted from the American Society for Testing Materials. Specification No. A3-15, they having been rewritten in the abbreviated form used by the Non-Ferrous Metals Division for S. A. E. Specifications.

Aluminum Alloy Specifications

At the request of H. L. Pope, of the Wright Aeronautical Corporation, the Division has considered including in the specifications of the Society the several classes of aluminum alloy specified in the Navy Department Specification No. 46A1 dated Jan. 2, 1924. It is believed that Class No. 2 alloy is used extensively enough in the automotive industry, in automobile body parts as well as in aircraft engine parts, to warrant its inclusion in the present specifications. The Division therefore recommends that the present Aluminum Alloy Specifications be extended to include Specification No. 35, which is based on the said Navy Department Specification No. 46A1.

Aluminum Alloy Specification No. 35

Composition in Percentage:

Aluminum, min.	92.50
Copper, max.	0.60
Iron, max.	1.00
Silicon	4.50 to 6.50
Zinc, max.	0.20
Manganese, max.	0.20

General Information.—The minimum tensile-strength of test-specimens about ½-in. in diameter of this alloy cast in sand and tested without machining off the skin, should be about 16,000 lb. per sq. in. with a minimum elongation of 3.5 per cent in 2 in.

This alloy is intended for automobile body parts and other parts that must be cast in thin sections. The alloy withstands salt-water corrosion very well and is therefore suitable for aircraft engine parts or other parts that may be subjected to severe corroding influences. The alloy has a relatively low yield-point and therefore cannot be used where great strength or stiffness is required.

Proposed Specification for Soft or Annealed Copper Wire

Composition.—The copper shall be of such quality and purity that, when drawn and annealed, it shall have the properties and characteristics herein required.

Shapes.—These specifications cover untinned drawn and annealed round wire.

Finish.—The wire must be free from all imperfections not consistent with the best commercial practice.

Necessary brazes in soft or annealed wire must be made in accordance with the best commercial practice.

Specific Gravity.—For the purpose of calculating weights, cross-sections, etc., the specific gravity of copper shall be taken as 8.89 at 20 deg. cent. (68 deg. fahr.)

Dimensions and Permissible Variations.—The size shall be expressed as the diameter of the wire in decimal fractions of an inch.

Wire shall conform to the following permissible variations in nominal diameter:

For wire 0.010 in. diameter and larger, 1 per cent over or under;

For wire less than 0.010 in. diameter, 0.1 mil (0.0001 in.) over or under.

Mechanical Requirements.—Wire shall be so drawn and

annealed that its tensile-strength and elongation shall not be greater nor less respectively than the values specified in Table 1. For wire whose nominal diameter is between listed sizes, the requirements shall be those of the next larger size included in Table 1.

TABLE 1—MECHANICAL REQUIREMENTS

Diameter or Thickness, In.		Tensile-Strength, Lb. Per Sq. In.	Elongation in 10 In., Per Cent
Over	To and Including		
0.460	0.290	36,000	35
0.289	0.103	37,000	30
0.102	0.021	38,500	25
0.020	0.003	40,000	20

Copper wire is usually purchased in B. & S. gage.

Electric Resistivity.—Electric resistivity shall be determined upon fair samples by resistance measurements at a temperature of 20 deg. cent. (68 deg. fahr.), and it shall not exceed 891.58 lb. per mile-ohm.

General Information.—As soft or annealed copper wire is so soft and ductile that it is easily marred by careless handling in the operation of winding or cabling, all testing and inspection must be done at the manufacturer's plant.

While international agreement upon the value 0.15328 ohm per meter-gram at 20 deg. cent. (68 deg. fahr.) for the resistivity of copper equal to 100-per cent conductivity was reached by the International Electro-Technical Commission in 1913, it has been deemed preferable to express the requirements in standard specifications in the terms of quantities directly measurable rather than by reference to some quantity whose standard value is the subject of agreement only. The use of the arbitrary term "conductivity" has no more warrant than the employment of arbitrary gage-numbers. Therefore, in these specifications the requirements are stated as the maximum rejection limits to the resistivity.

For the convenience of those who are accustomed to express resistivity in any one of the several more or less common units, the following equivalents have been prepared for the resistivity of copper at 20 deg. cent. (68 deg. fahr.), 891.58 lb. per mile-ohm is equal to 0.15614 ohm per meter-gram, 1.7564 microhm per centimeter-cube, 0.69150 microhm per inch-cube, or 10.565 ohms per mil-foot.

SCREW-THREADS DIVISION REPORT

Vice-Chairman O. B. Zimmerman

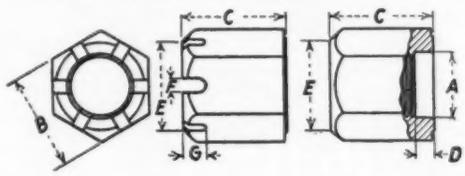
Although the Screw-Threads Division has not held a meeting since the latter part of 1923, it has been possible to approve by letter ballot Division recommendations covering High Nuts and Dimensional Tolerances. The recommendation for High Nuts was developed by E. H. Ehrman, chairman of the Division, acting as a subcommittee of one. The recommendation for Dimensional Tolerances was submitted to the Screw-Threads Division by the Special Committee on Methods of Expressing Limits and Tolerances, of which Earl Buckingham, of the Pratt & Whitney Mfg. Co., is chairman.

High Nuts

The following recommendation for High Nuts was developed by the Division as a result of the use of nuts of this type by engine builders interested in facilitating assembly and service.

The present S. A. E. Standard plain and castle nuts are designed so that the height allows sufficient thread to develop a shearing strength equivalent to the tensile-strength of the bolt. It has been found, however, that when the standard nuts are used in more or less inaccessible places, it is extremely difficult to obtain sufficient purchase on them with a wrench to permit easy removal or to obtain the proper tightness.

Proposed S. A. E. Standard for High Nuts



Size (A)	B	C	D	E	F	G
1/4	7/16	3/8	1/16	25/64	5/64	1/8
5/16	1/2	29/64	5/64	25/64	5/64	9/64
3/8	9/16	17/32	3/32	33/64	1/8	5/32
7/16	5/8	33/64	7/64	37/64	1/8	11/64
1/2	3/4	11/16	1/8	11/16	1/8	3/16
9/16	7/8	49/64	9/64	51/64	5/32	13/64
5/8	15/16	27/32	5/32	55/64	5/32	7/32
3/4	1 1/16	1	3/16	63/64	5/32	1/4
7/8	1 1/4	1 5/32	7/32	1 5/32	5/32	9/32
1	1 7/16	1 5/16	1/4	1 31/64	5/32	5/16

All dimensions in inches.

As it was generally believed that an extra-long nut was desirable as a standard product, from both manufacturing and servicing points of view, information was obtained from engine and automobile builders as to the present practice of those that were using this type of nut. This information showed that over 68 companies were interested in such standardization and Chairman Ehrman made a careful study of their current practice.

The dimensions used in current practice were plotted and although practice was found to vary to a considerable extent, proportions were determined on that were considered satisfactory for both design and production needs.

As the length of serviceable threads in the proposed series of slotted nuts is one diameter, and should not be less than this, the practice of counterboring instead of countersinking the face of the nut, as suggested by several manufacturers and users, is specified only for plain nuts.

On account of the somewhat limited use of plain nuts and the slight differences between the dimensions of plain and slotted nuts, it was not found advisable to establish a separate series for plain nuts.

Dimensional Tolerances

The accompanying five rules for specifying dimensional tolerances, which were submitted to the Screw-Threads Division by the Special Committee on the Methods of Expressing Limits and Tolerances, are based upon, and are intended to be supplementary to, the general information on dimensional tolerances approved at the 1924 Annual Meeting of the Standards Committee and now printed on p. M21 of the S. A. E. Handbook.

The rules, which were submitted to the members of the Passenger-Car, the Truck, the Engine and the Parts and Fittings Divisions for comment before they were acted upon by the Screw-Threads Division, met with complete approval. As a result of final Division action, the report of the Special Committee is transmitted to the Standards Committee for approval as an extension of the present general information on Dimensional Tolerances.

Proposed Rules for Dimensional Tolerances

Only one dimension in the same straight line can be controlled within fixed limits. That is the distance between the cutting surface of the tool and the locating or registering surface of the part being machined. Therefore, it is incorrect to locate any point or surface with tolerances from more than one point in the same straight line.

Every part of a mechanism must be located in each plane. Every operating part must be located with proper operating allowances. After such requirements of location are met, all other surfaces should have liberal clearances.

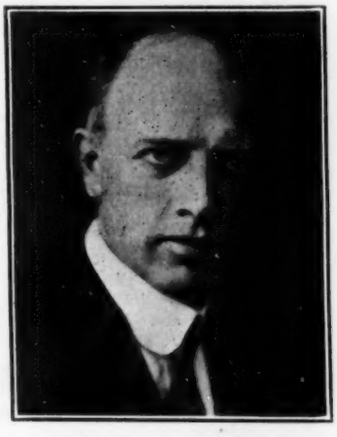
Dimensions should be given between those points or surfaces that it is essential to hold in a specific relation to each other. This applies particularly to those surfaces in each plane which control the location of other component parts. Many dimensions are relatively unimportant in this respect. It is good practice in such cases to establish a common locating-point in each plane and give, so far as possible, all such dimensions from these common locating-points. The locating points on the drawing, the locating or registering points used for machining the surfaces and the locating points for measuring should all be identical.

The initial dimensions placed on component drawings should be the exact dimensions that would be used if it were possible to work without tolerances. Tolerances should be given in that direction in which variations will cause the least harm or danger. When a variation in either direction is equally dangerous, the tolerances should be of equal amount in both directions, or bilateral.

The initial clearance, or allowance, between operating parts should be as small as the operation of the mechanism will permit.

The Special Committee on Methods of Expressing Limits and Tolerances plan to review all existing S. A. E. Standards and Recommended Practices and to recommend revisions of those standards not dimensioned according to the rules established.

SPRINGS DIVISION REPORT



CHAIRMAN F. A. WHITTEN

Since its report was submitted at the Standards Committee Meeting in White Sulphur Springs in 1922, the Springs Division has been, until recently, inactive, owing to the fact that the present spring standards were considered to meet all existing requirements. To confirm this understanding, a general letter was sent to the passenger-car and motor-truck builders in the latter part of 1923, asking them to review the present spring standards and to submit to the Society any information covering such revisions as might be considered desirable. The comments indicated general approval of the present standards, only a few slight changes being suggested.

In March of this year the Springs Division held a meeting in Detroit at which the few changes proposed were considered. The existing standards were also carefully reviewed and certain changes are recommended by the Division which have been made the subject of separate proposals.

MOTOR-TRUCK SPRINGS

The Springs Division recommends that the S. A. E. Recommended Practice for Motor-Truck Springs, p. H9 of the S. A. E. HANDBOOK, be extended to specify the same spring dimensions for 2½-ton trucks as are now specified for 2-ton trucks. This extension is proposed because many trucks using springs specified for trucks nominally rated at 2 tons are actually 2½-ton trucks.

LEAF-SPRING STOCK

It is believed that the most valuable standard the Division can sponsor is standard specifications for leaf-spring stock. The accompanying specification, developed by S. P. Hess and approved by the Division, is therefore submitted for approval as S. A. E. Recommended Practice with the hope that it will lead to the use in current design of the widths and the thicknesses listed. The rolling tolerances for leaf-spring stock are covered in the recommended practice on p. D99 of the S. A. E. HANDBOOK. The proposed stock dimensions will, if adopted, be consolidated with the tolerance requirements.

Proposed Standard Leaf-Spring Stock Dimensions

Width, In.	Thickness, B.w.g.	Width, In.	Thickness, B.w.g.
1¾	2	2¼	5
1¾	3	2½	3/8*
1¾	4	2½	5/16*
2	5/16*	2½	2
2	2	2½	3
2	3	2½	4
2	4	3	7/16*
2	5	3	3/8*
2	6	3	5/16*
2¼	3/8*	3	2
2¼	5/16*	4	7/16*
2¼	2	4	3/8*
2¼	3	4	5/16*
2¼	4		

*Thickness in inches, not B.w.g.

LEAF-SPRING DEFINITIONS

At the meeting of the Standards Committee at White Sulphur Springs in June, 1922, the recommendation for Leaf-Spring Definitions submitted by the Springs Division provoked considerable discussion and was finally referred back to the Division for further consideration. The Division has reviewed the definitions proposed in 1922 and submits the accompanying definitions that represent the former definitions revised in certain details. The definitions are intended primarily to apply to the conventional semi-elliptic type of automobile spring, but should be used where they may apply to the unconventional types of spring.

Proposed S. A. E. Standard for Leaf-Spring Definitions

Load.—The number of pounds to be carried by the spring. The Rated Load is the number of pounds to be carried by the spring at a given spring-height and includes the body, passengers or normal pay-load for which the vehicle is designed.

Unsprung Weight.—The total weight of all parts not supported on the springs, including springs, axles, wheels, rims and tires.

Spring Height.—The normal distance from a line through the centers of the spring-eyes to the face of the spring-seat at its center. The Load Height is measured with the spring under its rated load.

Clearance.—The maximum distance the spring can deflect from a given position. The Load Clearance is measured from the rated load position of the spring.

Opening.—The normal distance from a line through the centers of the spring-eyes to the face of the main leaf in line with the center of the spring-seat.

Length.—The distance between the centers of the spring-eyes. The Load Length is measured with the spring under rated load.

Flexibility.—The number of pounds required to deflect the spring 1 in. measured over the range of from 75 to 125 per cent of the rated load.

Deflection.—The travel in inches of the spring under the application of a specified load.

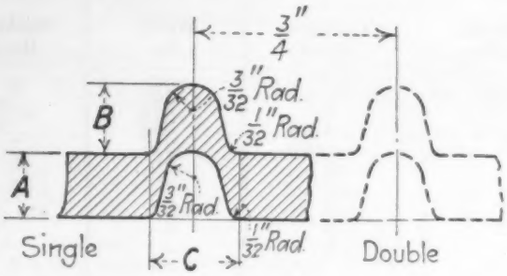
LEAF-SPRING NIBS

The present general information on shrunk center-bands includes a statement that, "Nibs shall be 3 in. in diameter and where two nibs are used the center-to-center distance shall be ¾ in."

It is believed that a definite recommended practice for spring nibs should be included in Section H and the Springs Division therefore recommends that the spring-nib dimensions specified in the accompanying table be adopted as S. A. E. Recommended Practice.

Proposed S. A. E. Recommended Practice for Leaf-Spring Nibs

When leaf-spring nibs are used, they shall be in accordance with dimensions specified in the accompanying table.



Type of Spring	A Min.	B	C Max.	C Min.
Passenger-Car	0.238	1/4	0.323	0.303
Motor-Truck	0.284	5/16	0.353	0.333

Spring Off-Sets and Resulting Ends

The Springs Division recommends that the present S. A. E. Recommended Practice for Spring Off-Sets and Resulting Ends, p. H7 of the S. A. E. Handbook, be cancelled. The practice recommended for the longer springs does not conform to the best practice of today. It is felt that, even though the standard were revised in this particular, it would not be of sufficient value to retain it in the S. A. E. Handbook.

Leaf-Spring Tests

The Springs Division has given considerable thought to the advisability of retaining the S. A. E. Standard for Spring Specifications, which may be considered to consist of two sections; one relating to specifications and the other to tests.

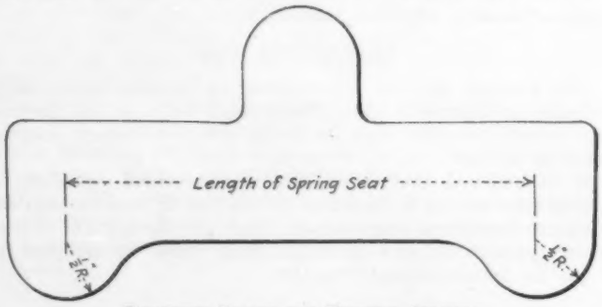
It was finally agreed that it is not advisable to retain that part of the standard relating to specifications because, even though the present specifications were extended to provide for all the data necessary for the various types of spring, it is a matter that should be left to the spring manufacturers to work out according to their individual practice.

The Springs Division therefore recommends that the present standard for Spring Specifications be limited to the information on spring tests. The present standard revised as proposed follows.

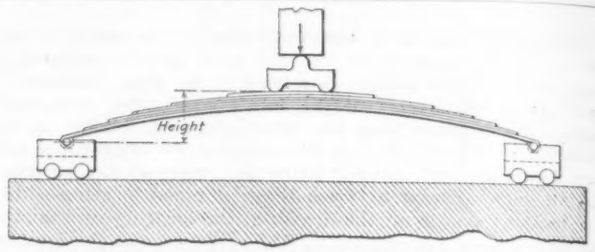
Proposed S. A. E. Standard for Leaf-Spring Tests

All leaf springs shall be tested in an upright position and supported so to permit free movement. All linear measurements shall be made to the nearest 1/64 of an inch. All load readings shall be made to the nearest load in pounds divisible by 5 lb.

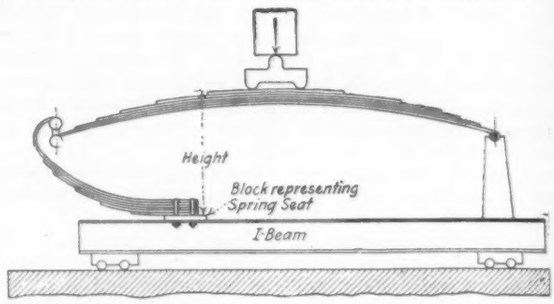
All tests or inspection measurements shall be made after rapping the leaf spring in the test or inspection position.



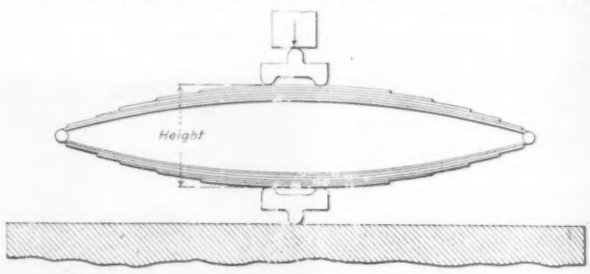
Pressure Block for Testing Springs



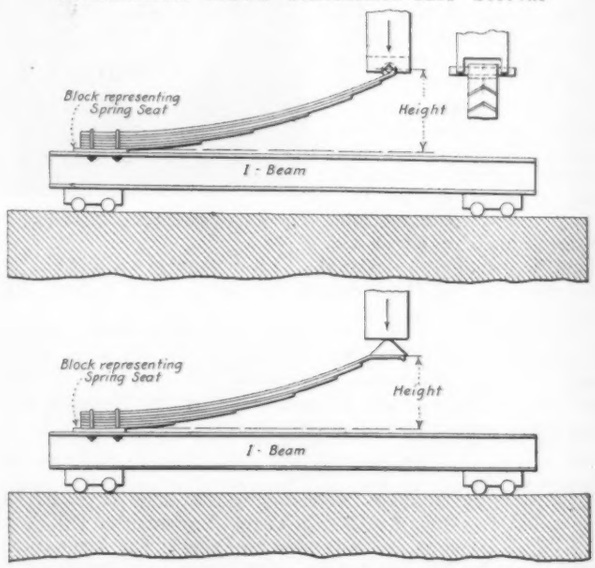
Half-Elliptic Spring Compression-Test Supports



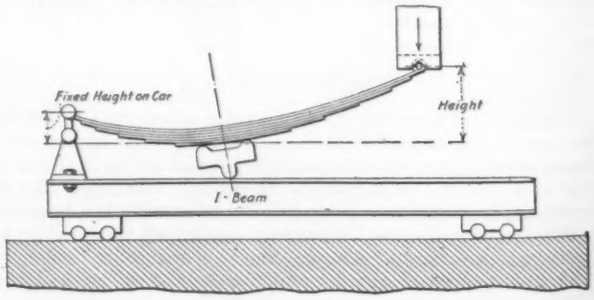
Three-Quarter Elliptic Spring Compression-Test Support



Full-Elliptic Spring Compression-Test Support



Quarter-Elliptic Spring Compression-Test Supports



Cantilever Spring Compression-Test Support

Chassis Lubrication

THREE different angles of the chassis lubrication problem were considered at the meeting of the Detroit Section held on April 3. Advantages of the centralized system were presented by Fred H. Gleason, while the magazine oiling system was described by Cornelius T. Myers and the use of rubber shackles to eliminate spring-shackle lubrication was discussed by A. F. Masury. Mr. Gleason's paper was printed in full in the April issue of THE JOURNAL and the other two papers are given below. The discussion following the presentation of these papers will, it is expected, be published in an early issue of THE JOURNAL.

NOTES ON CHASSIS LUBRICATION AND MAINTENANCE

BY A. F. MASURY[1]

ALL moving surfaces must have a film of lubricant between them to prevent contact and wear and tear. Chassis lubrication, although the subject of much thought and effort, has had no radical development. The motions in a motor-vehicle chassis that require lubrication are of two kinds (*a*) rotary motion, as in the engine, the transmission, the axles and the wheels; and (*b*) alternating motion, as in the springs, the shackles, the various controls, the brake shafts and levers and the pedals. Some of the unpleasant lubrication has been avoided by the use of fabric universal-joints on the drive shaft and by the Fergus lubrication system. But a lubricant that is satisfactory for the engine will not be suitable for the rear axle. A simple solution of the problem is not easily to be found.

The elements of the motor vehicle that require the most constant care to obtain satisfactory operation are the anchors of the suspension springs and their shackles. Impacts received by the tire in passing over a rough road are imparted to the axle and, in turn, to the spring anchor and the shackle. The grease is squeezed out and has not time to flow back before the next shock is received. Leather gaiters protect the shackles from the weather but do not prevent wear. Daily lubrication of the shackles by fleet owners is therefore necessary.

As oil changes in consistency with the temperature it is gradually giving way to grease. Pressure grease-guns with protected inserts have helped to increase the useful life, but all lubricants are an economic waste and the elimination of unnecessary work would allow better service to be rendered.

By substituting a non-metallic resilient material capable of absorbing the necessary motions, carrying the maximum loads and doing away with the lubricant entirely, the drawbacks and inconveniences heretofore present in spring shackles have been overcome. Blocks of rubber enveloping the ends of the suspension springs meet these conditions. Graphs taken from seismographic machines show the action of rubber shackles under varying road conditions as compared with that of standard metallic shackles. The rubber is seen to cushion and iron out the ripples of the ordinary road. Its presence between the running gear and the sprung weight prevents the transmission of road shocks to the body and therefore deadens the noise. The flexibility of spring anchors due to the compressibility of the rubber serves to reduce breakage of the springs.

Rubber shackles can be applied to all types of spring suspension and are particularly adapted to the Hotchkiss drive. Starting and stopping shocks are avoided and skidding is reduced. The durability of the rubber is attested by the fact that after 100,000 miles of motor-bus work it apparently was none the worse for wear. In service, statistics show that by saving rebushing of the springs, or the shackles, and replacing of the pins, a saving of from $90 to $125 per year per vehicle is effected, not including the cost of up-keep, that is, the cost of lubricant and labor.

Statements are submitted showing savings, by the Fifth Avenue Coach Co., of $80 per year per vehicle and, by the Yellow Cab Co. of Chicago, of 0.5 cent per cab-mile, or approximately $120,000 per year. Replacements of rubber shackles are easily and simply made.

Illustrations are given of installations of rubber shock-absorbers on a truck, a motorbus, a Sterling Knight car and a rail-car and of variations in the arrangement of the insulators.

EVER since the conception of the motor vehicle, chassis lubrication has been a subject to which automotive engineers have devoted much thought and effort. Although this topic has often been discussed, no radical development has ever been brought forth, notwithstanding that useful devices and methods have been developed to lengthen the serviceable life of the moving parts of the vehicle.

Any mechanical motion imparted to a combination of elements movable relatively to one another or to the mechanism cannot be sustained for an indefinite period unless the parts are properly lubricated. A film of lubricant must always be between the rubbing surfaces to prevent direct contact and, therefore, wear and tear.

As the automobile and its derivatives, the motor truck and the motorbus, more and more become transportation units, automotive engineers should strive to simplify the design of the vehicles and to reduce the number of the parts that at present require the most care for their continuous and satisfactory operation. One might add also that, although the demand for cheaper automobiles will undoubtedly continue and possibly increase, more economical transportation and better service will be demanded by the public.

The lack of duration, or useful life, of the parts of a motor vehicle is not always due to faulty material or manufacture, but rather to the fact that the engineer has failed to grasp thoroughly the fundamentals underlying the problem and has drawn conclusions leading to unsatisfactory design.

Chassis lubrication is one of the problems that still

[1] M.S.A.E.—Vice-President and chief engineer, International Motor Co., New York City.

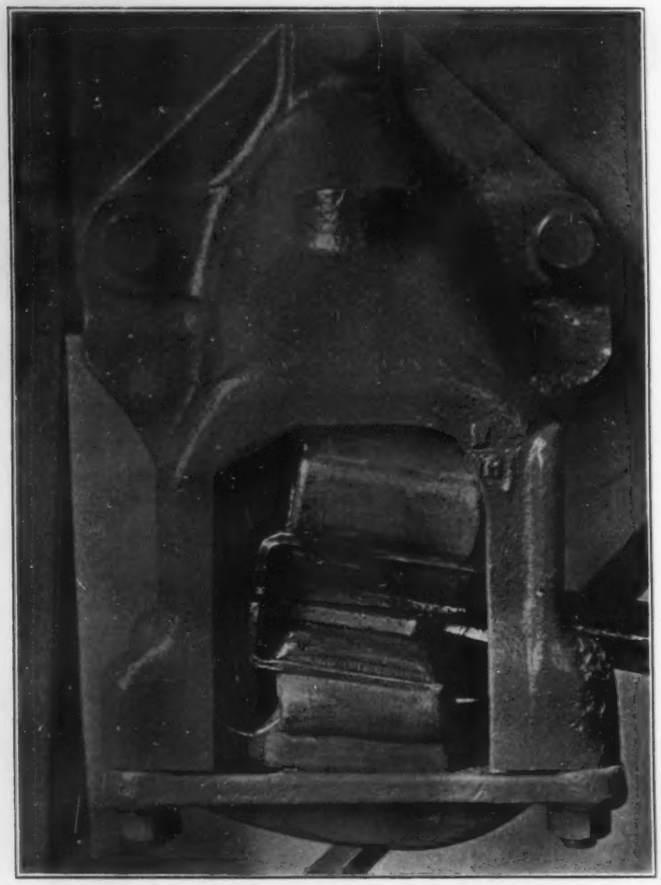


FIG. 1—RUBBER SHACKLE OR SHOCK INSULATOR MOUNTED IN BRACKET
Part of the Bracket Has Been Cut Away To Show How the End of the Spring Is Held in the Rubber Block

requires analytical study before any absolutely satisfactory solution can be reached. The motions in a motor vehicle that require chassis lubrication are of two kinds; (*a*) rotary motion as in the engine, the transmission, the axles and the wheels and (*b*) alternating motion, as in the springs and shackles, the various controls, the brake shafts and levers and the pedals.

Much of the unpleasant chassis lubrication applied to rotating parts has been eliminated by the use of fabric universal-joints on the drive-shaft, which is generally hard to reach. The development of the Fergus lubrication system, using a single oil-filler located in the engine compartment to lubricate every component of the chassis, was a step in the right direction, but I believe the relatively high first cost prevented its universal use. On the other hand, one might raise the objection that a

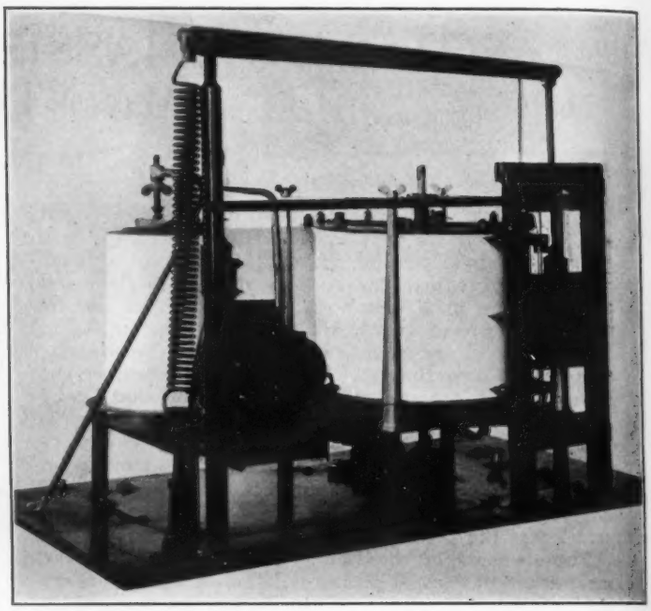


FIG. 3—SEISMOGRAPH USED TO DETERMINE RIDING QUALITIES
The Paper Record Chart Is Rolled from the Storage Spool at the Left to the Record Spool at the Right as the Latter Is Rotated by a Flexible Drive from a Front Wheel of the Vehicle. The Seismograph Weight Moves Vertically Along Guides as the Instrument Encounters Vertical Jolts; a Pencil Attached to the Weight Records the Movement upon the Chart by a Pencil Actuated from a Phonograph Motor Properly Governed

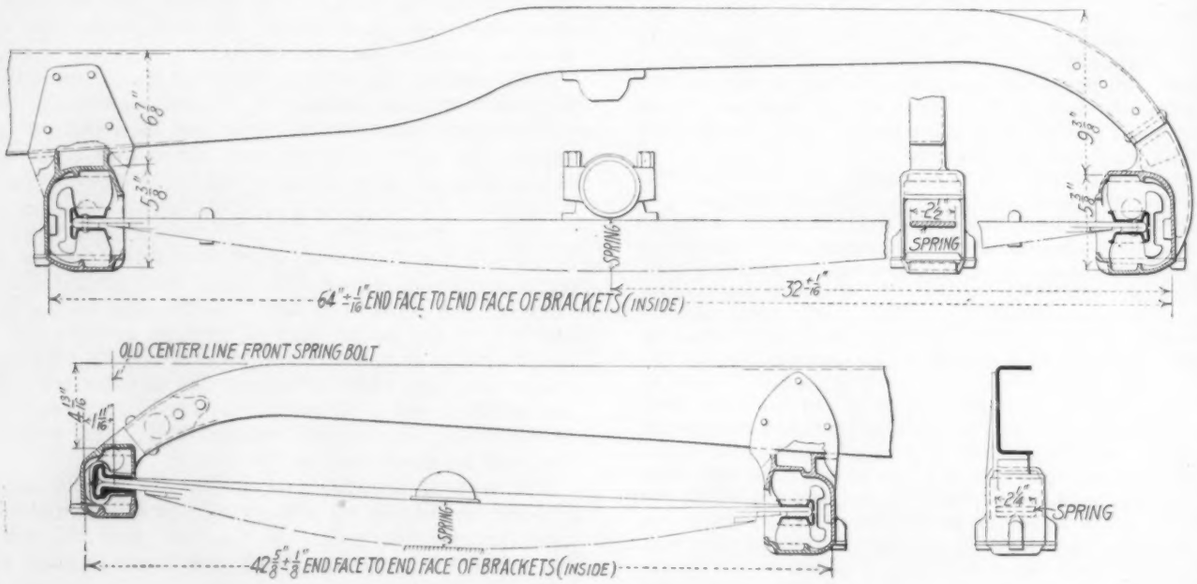

SPRING
SPRING
64" ± 1/16" END FACE TO END FACE OF BRACKETS (INSIDE)
32" ± 1/16"
OLD CENTER LINE FRONT SPRING BOLT
SPRING
42 5/8" ± 1/8" END FACE TO END FACE OF BRACKETS (INSIDE)
SPRING

FIG. 2—SECTION THROUGH THE RUBBER SHACKLE OR SHOCK INSULATOR
This Shackle Is a Block of Molded Resilient Rubber That Envelops Each End of a Suspension Spring. Instead of Having the Spring Eyes Forged at the Ends of the Spring, They Are Merely Bent Over through an Angle of 180 Deg. and Pressed-Steel Cups That Receive the Rubber Blocks Are Riveted to Them

lubricant that is satisfactory for the engine will not suit rear-axle conditions. All this leads us to realize that proper chassis lubrication is, indeed, a complex problem deserving very serious thought before arriving at a simple solution. To confirm this, I need only mention the extensive educational campaigns conducted by the different oil companies to instruct the motoring public; also the various lubricating charts issued by the motor-vehicle builders.

Lubrication of Springs and Shackles

I shall not take up every phase of chassis lubrication, but shall confine my remarks to the elements of a motor vehicle that require the most constant care for their satisfactory operation, the anchors of the suspension springs and their shackles.

If we stop to study analytically the problem that

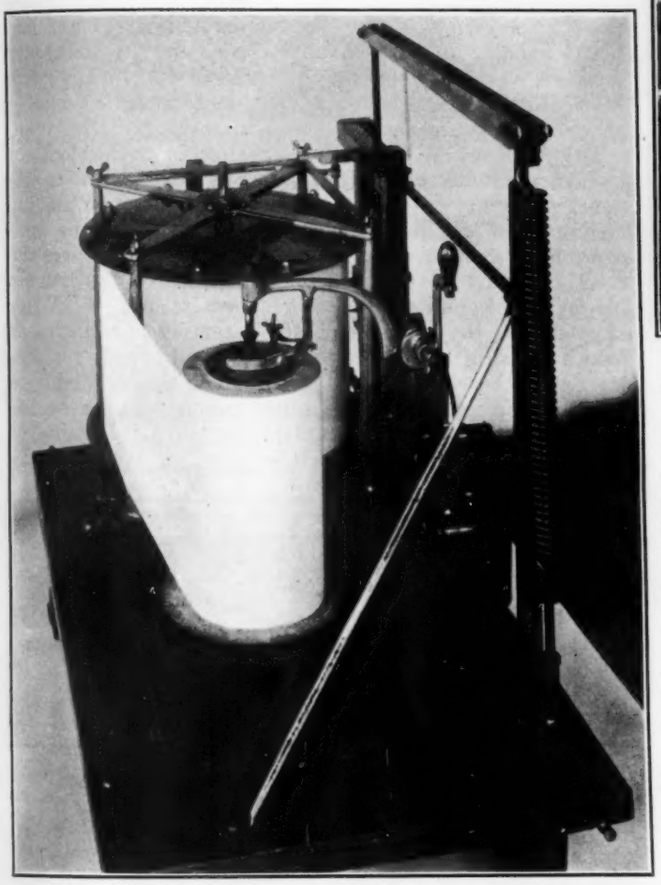


Fig. 4—End View of the Seismograph
This Gives a Better Idea of the Two Spools Containing the Record Strip and the Mechanism for Controlling Their Rate of Rotation

confronts us, we cannot help but reach the conclusion that no oil, or even grease, constantly under pressure can fulfil the extreme lubrication requirements of the existing type of spring anchor and shackle.

Let us take the typical example of a motor vehicle traveling over a rough cobblestone road, such as is commonly found in every city. Every time the tire rolls over a paving stone, the impact produces a rapidly accelerated motion, varying in amplitude from, say, 0.5 to 2.0 in height, which is imparted to the axle. The spring transmits one-half of this load to the spring anchor and the other half to the shackle with the same rapidity. This sudden shock is resisted through the

Fig. 5—The Seismograph Mounted on the Floor of a Bus
In This Position All Vibration of the Body Resulting from Variations in the Road Surface Can Be Easily Recorded

bearing surfaces by the inertia of the body. The film of oil, or grease, that was on the loaded side of these bearing surfaces is squeezed out, and has not time to flow back before the next shock is received. It can easily be conceived, therefore, why spring shackles, under such operating conditions, are among the first parts of the chassis that need to be replaced.

I hope that I need not stress further the practical impossibility of keeping a constant film of lubricant between bearing surfaces that are subjected to impact loads of this nature, especially as the spring shackles are in the majority of cases unprotected from road conditions and weather inclemencies. The use of leather gaiters, of course, obviates the effects of the latter. They do not, however, prevent wear, and they present, therefore, only a remedy and not a solution.

To prevent the untimely replacement of these parts, fleet owners of motor vehicles provide for the daily

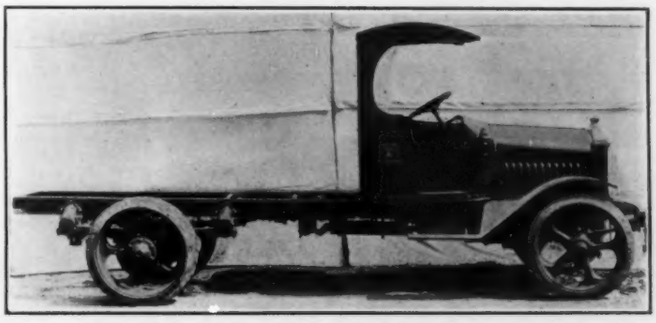


Fig. 6—A 2½-Ton Truck Chassis Equipped with Shock Insulators
All of the Smaller Tonnage Mack Trucks Are So Equipped

lubrication of spring shackles, and individual owners are instructed to lubricate them every so many miles or weeks, if they do not forget. No exact rule can be fixed because of the unknown factors, such as road conditions, weather, cleaning and the like.

It might be mentioned that comparatively recent developments, such as the use of pressure grease-guns with protected inserts, have helped to increase the useful life of these parts. Oil seems to be giving way to grease, probably because the consistency of grease changes at different temperatures. It would seem, then, that if we cannot satisfactorily keep the lubricant so that it will be effective at all times, we have attacked the problem wrongly. As a matter of fact, all this lubricant might

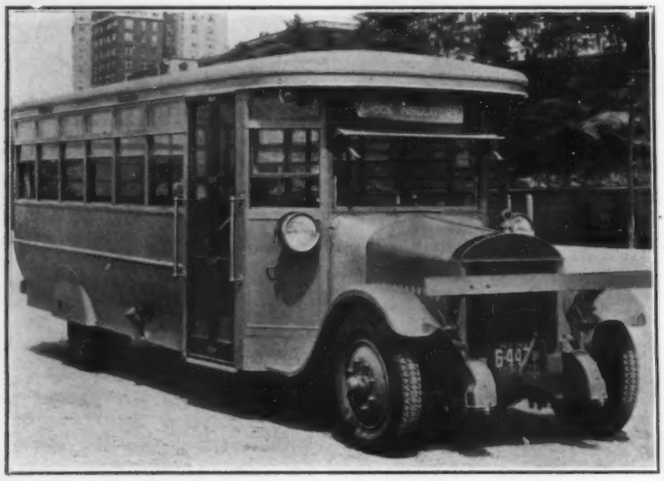


FIG. 7—A BUS EQUIPPED WITH SHOCK INSULATORS
The Floor of This Bus Is Only 24 In. from the Ground

be classed as an economic waste that is gaining in magnitude as the number of cars increases. Any waste is equivalent to an increase of service cost and therefore retards progress.

Many service-stations are overburdened with work that could have been prevented by the proper study of the basic principles involved in the original design. The spring shackles are no exception to this rule. The elimination of unnecessary work would permit a company or an individual in business to render better service when needed and would be conducive to success, because the most important asset of a business is the service that is given after the sale of the products.

THE RUBBER SHACKLE OR SHOCK INSULATOR

How shall we eliminate all the drawbacks and inconveniences that in the past have caused spring shackles to be the most troublesome parts for the motor-car owner

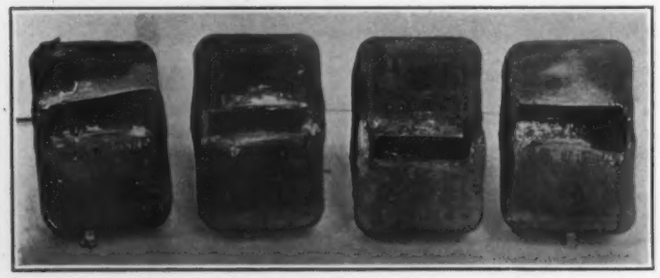


FIG. 8—A SET OF FRONT SPRING SHOCK INSULATORS AFTER 100,000 MILES OF SERVICE
This Set of Shock Insulators Was Installed on a Bus and Apparently Is None the Worse for This Hard and Continuous Service

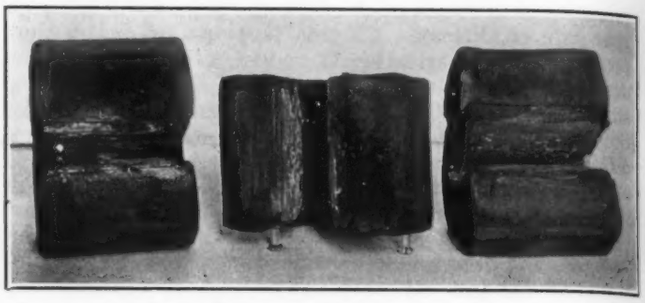


FIG. 9—THE REAR BLOCKS CORRESPONDING TO THE FRONT ONES SHOWN IN FIG. 8
These Blocks Show No Signs of Wear. Other Sets Have Been Run over 200,000 Miles in Trucking Service without Reaching the End of Their Serviceable Life

by necessitating his periodical and consistent care to make them function properly? Why not substitute in their place elements made of non-metallic resilient material capable of successfully absorbing the necessary motions, carry the maximum loads and do away with lubrication entirely? Such is the purpose of rubber shackles, known also as shock insulators.

Briefly described, the rubber shackle is a block of molded resilient rubber that envelops each end of a suspension spring, as shown in Fig. 1. Instead of having spring eyes forged at the ends of the spring, the ends are merely bent over an angle of 180 deg. and pressed-steel cups are riveted to them to receive the rubber blocks, this construction being shown in Fig. 2. When slipped over the spring end, the assembly is compressed into a housing riveted to the frame and which replaces the spring bracket. A bolted cap holds this assembly in position and under predetermined compression, assuring long life. Due to its complete housing, this type of shackle is not affected by either road or weather con-

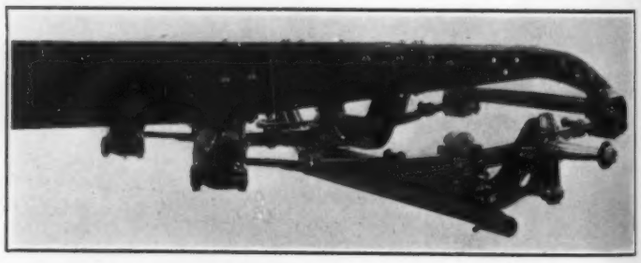


FIG. 10—FRONT-SPRING ASSEMBLY OF A PASSENGER CAR
This Gives a Very Clear Idea of the Position of the Rubber Shock Insulators in Relation to the Other Chassis Parts

ditions. It permits thorough cleaning, therefore, and does not offer the unsightly appearance of the dirty and oily metallic shackle.

To study thoroughly the action of the rubber shackle under varying road conditions, the company with which I am associated has made use of the seismographic method of vibration study and has developed the seismograph shown in Figs. 3 and 4.

Fig. 5 shows the instrument mounted on the floor of a motorbus ready for operation.

A comparison of graphs made on trucks equipped with the standard metallic shackle with those made on trucks mounted on shock insulators disclosed the fact that the rubber shackle absorbs the first inch or so of axle and spring deflection due to the irregularities of the road. In other words, it cushions and irons out all the ripples of the ordinary road. This is a distinct advantage. Furthermore, the presence of rubber between the run-

ning-gear and the sprung weight prevents the direct transmission of road shocks to the body and, therefore, deadens the noise.

The flexibility of the spring anchors has the great advantage of considerably reducing the spring breakage in view of the fact that the rubber compresses under sudden increases of load and, therefore, relieves the top leaves of the spring from extreme stresses, due to torsional strain. The latter is one of the causes of shackle-pin wear in ordinary construction. It has been claimed that such spring breakage, in a particular case, was 85 per cent less than the previous amount.

Rubber shackles are not limited to the semi-elliptic

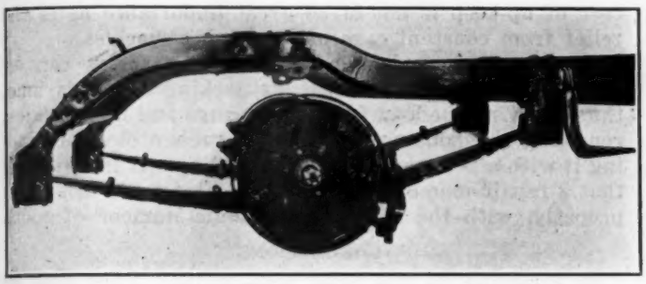


FIG. 11—REAR-SPRING AND REAR-AXLE ASSEMBLY OF A PASSENGER CAR
This Illustration Shows the Castings Enclosing the Shock Insulators at the Extremities of the Spring

type of spring, but have been designed and applied to all types of suspension, and are peculiarly well adapted to the Hotchkiss-drive method. The action of transmitting the propulsive effort or the braking effort, as the case may be, through the thrust section of the rubber shackle avoids all the annoying starting and stopping shocks. Skidding is decreased in a measure by the give of the rubber, and the safety of the passengers is correspondingly enhanced.

They insulate, so to speak, the vibrations of the running-gear from the sprung weight. This point, I am sure need not be dwelt on at length, for everyone has experienced the difference between leather heels and rubber heels on footwear.

For over 2 years the company with which I am associated has equipped with rubber shackles all its motorbuses and motor trucks of small tonnage capacity. Fig. 6 shows a 2.5-ton truck chassis so equipped. Fig. 7 is a photograph of our new shock-insulated low motorbus. The floor height of this motorbus is only 24 11/16 in. from the ground.

The simplicity of construction of the rubber shackle

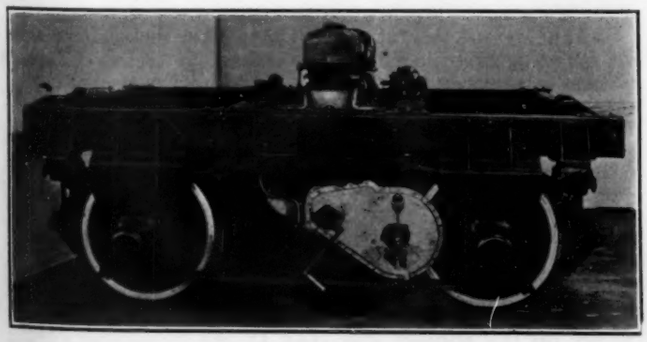


FIG. 12—ANOTHER APPLICATION OF RUBBER SHOCK INSULATORS
The Power Truck of a Motor Rail-Car. The Shock Insulators Are Mounted in Cups That Are Attached to the Truck Frame by Heavy Riveted Brackets

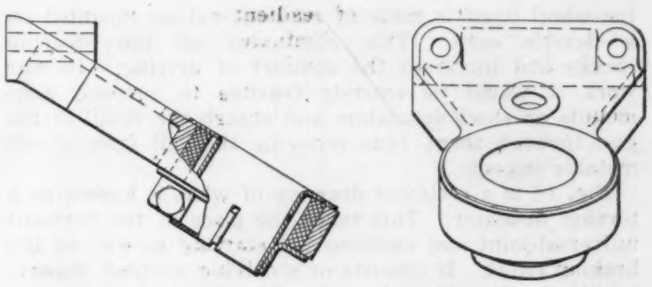


FIG. 13—MOUNTING THE STEERING COLUMN ON THE DASHBOARD TO ELIMINATE DRIVING SHOCKS AND INCREASE DRIVING COMFORT
The Column Passes through a Rubber Shock-Insulating Ring in the Dashboard Bracket and the Steering Wheel Is Made of Resilient Rubber Mounted on a Flexible Core

makes it durable. No lubrication ever is needed for the spring ends. As a matter of fact, when once installed on a vehicle, they might as well be forgotten for at least the first 150,000 miles. Fig. 8 shows a set of front-spring shock insulators that has seen 100,000 miles of motorbus work and looks apparently none the worse for

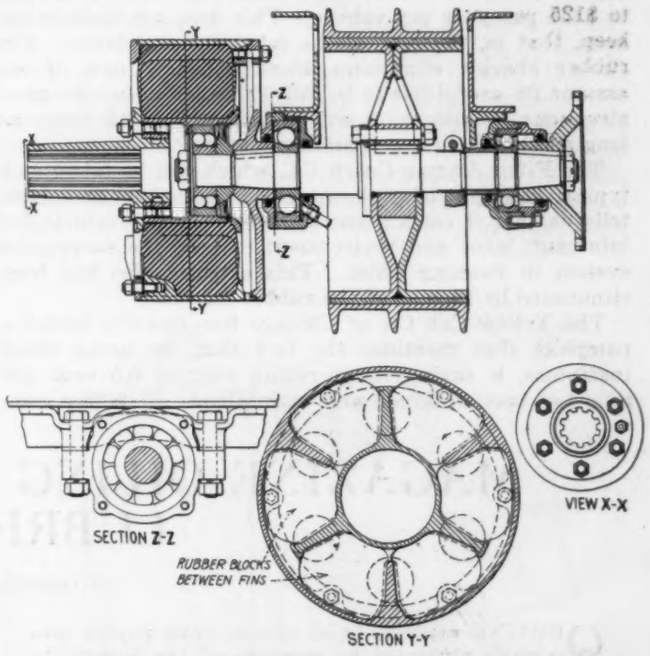


FIG. 14—SECTIONAL DRAWING OF A TORSION INSULATOR
This Insulator, Which Consists of a Driving Member Imparting the Driving Effort through a Number of Rubber Blocks to the Driven Member or the Propeller-Shaft, Is Intended To Replace the Forward Universal-Joint and Cushions the Starting as Well as the Braking Effort

this hard and continuous service. Fig. 9 illustrates the rear blocks of the same motorbus. Many other sets have been running for 200,000 miles and over, doing continuous trucking work, and the limit of their serviceable life has not been reached.

Figs. 10 and 11 show the standard installation on the Sterling-Knight car.

The use of rubber in motor-vehicle construction is almost unlimited and is not confined to passenger cars, motor trucks or motorbuses, but may be adapted to any construction or design in which the amount of motion required is not too great.

Fig. 12 is a photograph showing the details of the power truck of a rail-car mounted on shock insulators. Fig. 13 is the mounting of the steering post on the dashboard and shows the rubber insulating ring. The steer-

ing-wheel itself is made of resilient rubber mounted on a flexible core. This eliminates all the steering shocks and increases the comfort of driving. In war work it would be entirely feasible to suspend gun-mounts on shock insulators and absorb the recoil of the gun through them, thus relieving the rail from direct metallic impact.

Fig. 14 is a sectional drawing of what is known as a torsion insulator. This takes the place of the forward universal-joint and cushions the starting as well as the braking effort. It consists of a driving member imparting the driving effort through rubber blocks to the driven member or propeller-shaft.

Service Comparison

Laying aside all the considerations and advantages previously enumerated, to realize fully the value of rubber shock-insulators it will be necessary to compare the results obtained by their application and use on motor vehicles in terms of service. Actual statistics show that, in motor truck operation, springs or shackles are rebushed and pins often replaced on account of wear every 10,000 or 15,000 miles. This entails a cost of from $90 to $125 per year per vehicle. This does not include upkeep, that is, the cost of the lubricant and labor. The rubber shackle eliminates these expenses and, if we assume its useful life to be 100,000 miles under the most strenuous conditions, it will last from 7 to 10 times as long and result in a proportional saving.

The Fifth Avenue Coach Co., which can be taken as a typical example of well-organized motorbus operation, tells us that it costs about $80 per year per vehicle for lubricant, labor and replacement to keep the suspension system in running order. This expense also has been eliminated by the use of the rubber shackles.

The Yellow Cab Co. of Chicago has recently issued a pamphlet that mentions the fact that, by using shock insulators, a saving in operating cost of 0.5 cent per mile has been obtained and maintained. A better comprehension of this saving in expense can be gained by saying that the average taxicab mileage is about 28,000 miles per year and the accumulated mileage of all rubber-shackled cabs is approximately 24,000,000; this is equivalent to a saving of $120,000 per year.

To confirm these reports, a taxicab operator in one of the largest cities of the Country recently stated that shock insulators have decreased his operating expenses from $80 to $100 per year per cab. He estimated the useful life of the ordinary steel spring-shackle to be from 22,000 to 25,000 miles. Assuming conservatively the life of rubber shackles to be 150,000 miles for passenger-car work, they will last six or seven times as long as the existing type. To the individual owner, the cost of up-keep is not of so great importance as is the relief from constant care of the spring-shackles.

Furthermore, replacing the rubber shackles can be done with the greatest ease by jacking-up the frame, thus relieving the load from the springs and the shackles, removing the housing-cap and the rubber block, replacing it with a new block and reassembling. It is so simple that a repair man can easily be educated to do this work properly, with the aid of a minimum number of tools.

Conclusions

In summing up this brief presentation, I am sure all will agree that the suppression of the eight most troublesome parts of a motor vehicle that require chassis lubrication is bound to have a beneficial effect on the mind of the buying public, especially when it is considered that by riding on eight blocks of rubber, greater comfort, due to the elimination of sudden shocks and sharp metallic noise, has also been obtained. All this appeals greatly to every motor-car owner and is worthy of serious thought by every automotive engineer.

The absence of accurate machinework in the production of rubber shackles means an appreciable reduction of capital investment, labor and overhead expense for the car builder and for the service-station.

MAGAZINE OILING SYSTEM OF CHASSIS LUBRICATION

BY CORNELIUS T. MYERS[2]

QUOTING expressions of opinion from papers previously presented by members of the Society, to the effect that a car should have no unlubricated joints and that chassis parts would come to be lubricated by a design for carrying a supply of oil at the various necessary points and that only occasional replenishment would be required, the author refers to the importance of the subject of chassis lubrication as having been evidenced by a favorable letter ballot that a paper be presented on this subject before one of the Sections in 1921 and gives an illustrated description of the chassis-lubrication system he advocates.

Among the advantages claimed for the system are the elimination of squeaks and rattles; easy springs; easy steering; effective, but quiet brakes; and but slight wear on the chassis bearings.

SOME 12 years ago, as Vice-Chairman of the Detroit Section, I presided over a meeting at which chassis lubrication was mentioned in passing. It passed very quickly, in fact, for in those days we were much more interested in the major elements of the car such as engines, axles, frames, transmission gears and the like, but since then the subject has bobbed up again and again serenely and patiently.

In 1919 William B. Stout emphasized it in a paper on What Motor Cars Could Be,[3] read before the Society. He said:

> The car of the future should be designed primarily with the owner in mind, rather than the factory. This means a car that can be taken care of by the owner with a small outlay of effort or skill and infrequent oiling; a car with no grease-cups or unlubricated joints,...."

In 1921, the Metropolitan Section of the Society took a letter ballot on subjects for its program. Now the New York City district uses more automobiles and motor trucks than any other locality in the world, and it is significant to note that Chassis Lubrication received a larger vote than any other subject. A comprehensive paper on the subject was read at the November, 1921, meeting.

Our cars are so remarkably reliable that their small needs are habitually neglected by the owner. This

[2] M.S.A.E.—Chassis Lubricating Co., Rahway, N. J.

[3] See TRANSACTIONS, vol. 14, part 2, p. 149.

neglect entails a big repair bill, it is true, but the owner's time is usually worth far more to him than the bill. But should we build cars so that the small but important bearings are sent unprotected into a hurrying world that is prone to forgetfulness and procrastination? Bit by bit we have narrowed manufacturing specifications

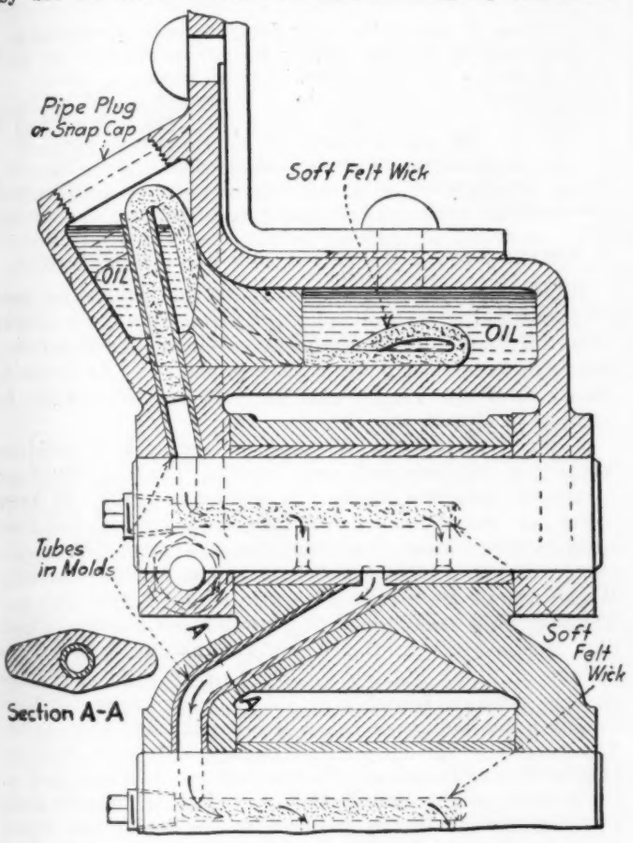


FIG. 15—FRONT SPRING-SHACKLE ASSEMBLY OF A 5 TO 7-TON TRUCK

The Same Brackets Are Used at the Front and the Rear of the Spring and the Three Spring-Bolts Are All Alike. These Bolts Are Inexpensive, Being Made of S. A. E. No. 1020 Cold-Rolled Stock without Heads or Threaded Ends, and Seem To Last Indefinitely. The Series Feed, through a Tube Cast into the Shackle, Successfully Enables One Magazine To Lubricate Both Bolts

down to the last half thousandth of an inch, and up to 70 or 80 points on the scleroscope. Yet chassis bearings by the million *pitifully squeak* and *spitefully knock* their way to swift and sure destruction, all because they lack the automatic lubrication we give to the main units.

In days past, chassis lubrication has suffered because

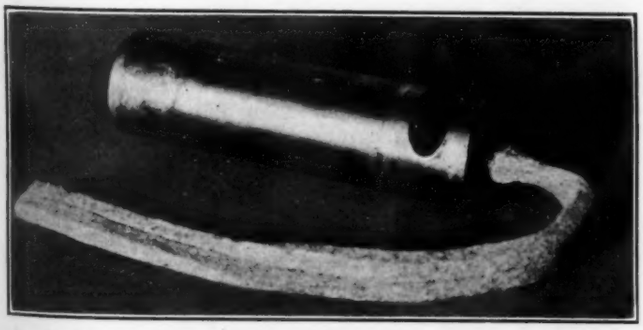


FIG. 16—THIS SPRING BOLT WAS REMOVED FROM A 7-TON MOTOR TRUCK THAT HAD TRAVELED MUCH MORE THAN 100,000 MILES

The Average Wear Was 0.003 In. and the Out of Round 0.002 In. The Lubricant Used in the Magazines Was the Thin Dirty Oil Drained from the Crankcase of the Engine. The Material in the Bolt Is Cold-Rolled and Case-Hardened S.A.E. No. 1020 Steel

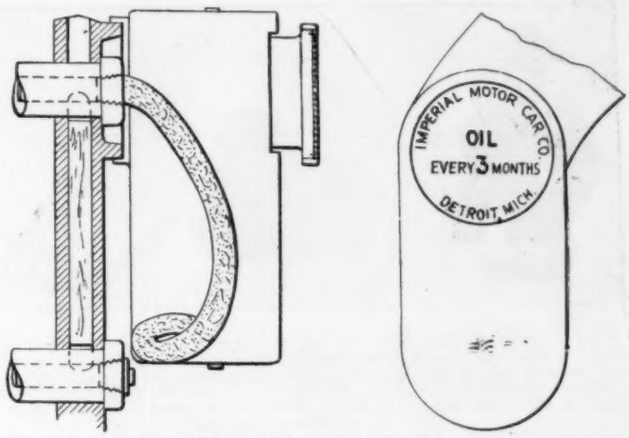


FIG. 17—A STAMPED-METAL MAGAZINE APPLIED TO FRONT AND REAR SPRING SHACKLES

These Magazines Are All of the Same Size, but Can Be Made in Any Form Required. They Fit Tightly over a Small Shoulder on the Bracket or the Shackle and the Bolts Can Be Assembled or Withdrawn through the Filling Nozzle. Metal Caps Snap on with a Pinch of the Fingers and Are Released by a Push in the Center

more pressing problems had to be met and solved. But it is with us now in earnest and, before long, it will be dinned into the ears of car salesmen. One of its most ardent advocates is daily telling the public, in an advertising campaign costing thousands upon thousands of dollars, that each and every one of us must lubricate all the dirty and unhandy parts of our cars *every* 500 *miles*. We are told also that if we do not do it we shall have a repair bill bigger than the coal bill. Knowing right

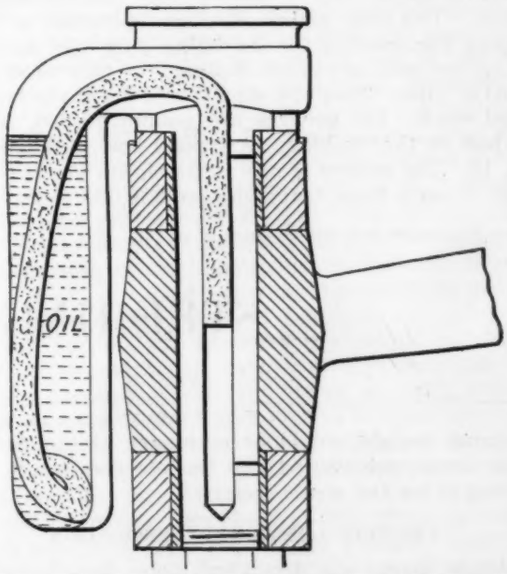


FIG. 18—ANOTHER APPLICATION OF THE MAGAZINE OILING SYSTEM

This Form Is Used for Steering-Knuckle Pivots and Tie-Rod Connections and Has the Same Type of Snap Cover as Is Illustrated in Fig. 17

well that we not only do not do it but will not do it, thousands of stations throughout the Country are being equipped where "George will do it," *for* $1 *or more.*

LUBRICANT SUITABLE FOR CHASSIS USE

My 13 years of sad experience in using grease of all kinds and in every way suggested has completely discouraged its further consideration where it is possible to use oil. The testimony of scores of fleet operators at present confirms this conclusion, and the engineers of

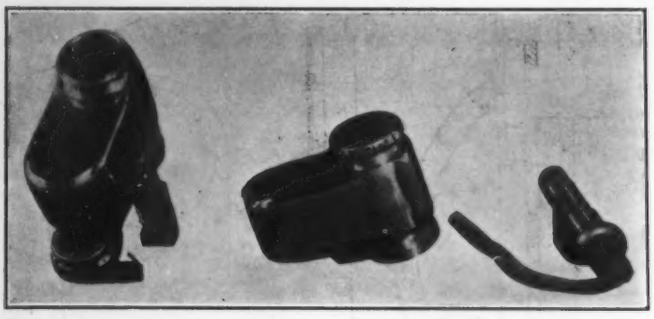


FIG. 19—THE STEEL MAGAZINE AS APPLIED TO A FORGED SHACKLE
The View at the Left Shows How the Spring Bolt Can Be Assembled or Withdrawn from the Complete Magazine Illustrated in the Center. The Snap Cap Can Be Seen in Place in This View. The Spring Bolt and the Wick after Being Withdrawn from the Magazine Are Shown at the Right

many a passenger-car company strongly favor oil over grease for the lubrication of chassis bearings.

In 1916, I made the first commercial application of the Myers magazine oiling system. Briefly, the system consists of small magazines incorporated with or attached to each bearing or group of bearings. Light oil is slowly but automatically fed to the bearing whenever needed by a large felt wick. This wick also filters out any dirt and excludes moisture. To date, nearly 30,000 chassis have been equipped with the various devices of this system. One of these, as applied to the front-shackle assembly of a 7-ton truck, is shown in Fig. 15.

The hollow castings average very little heavier than the ribbed type; but, because of the better metal distribution in a "box" section, they are stronger and stiffer. The only added machine operation is that of tapping the opening for the filling plug. In many cases the spring bolts are much cheaper, for they need have no heads or nuts. They are shorter and are made from cold-rolled stock. Oil grooves are seldom needed, either in the bolt or the bushing. A typical bolt is illustrated in Fig. 16. The system is now in its eighth year of service. Many chassis have traveled over 150,000 miles and, as yet, we have not heard of the failure or replacement of any bearing so lubricated.

At the risk of finding a change in his opinion if he is present, I quote from President H. M. Crane's paper on What Motor Cars Could Be,[4] read before the Society. Society about 4 years ago.

> I hope to see in the near future a very considerable improvement in the quality of our production as to both design and workmanship, in all grades of cars....
>
> I think that we shall see an increased use of oil for lubricating other chassis parts than the engine, and that this use will be simplified, as it has been in many other commercial lines, by a design allowing for carrying a supply of oil at various necessary points, only occasional replenishment being required.

OILING DEVICE MATERIALS AND RESULTS OBTAINED

While cast devices can readily be and are being used on passenger cars, their adoption often calls for a change from forgings and stampings to castings. To avoid this, we have developed devices in pressed steel or brass as shown in Figs. 17, 18 and 19. These can readily be applied to almost any chassis.

A slight seepage of oil from the spring-bolt bushings keeps the springs soft and flexible. Spring breakage is almost unknown where the system is used. In some cases the "mags" hold a 6-months' supply of oil, but none need be filled more than four times a year. As a car-owner, all you need remember about chassis lubrication is Washington's Birthday, Decoration Day, Labor Day and Thanksgiving Day; make that your chassis-oiling schedule. Some time in those weeks have the man at the garage or filling station spend 10 or 15 min. oiling the chassis with a squirt gun or a quart measuring-can having a flexible nozzle after he has put oil in the engine. The results: No squeaks or rattles, soft easy springs, easy and sure steering, effective but quiet brakes and so little wear on the chassis bearings that, when you come to trade the car in for a new one, the dealer can afford to allow you $50 to $150 more than usual because he does not have to overhaul the chassis to sell the car for a fair price.

[4] See TRANSACTIONS, vol. 14, part 2, p. 156.

STEERING-GEAR ANALYSES

(*Concluded from p.* 590)

how much weight would be necessary at the periphery of the drum substituted for the steering-wheel to lift the weight on the steering-arm.

FRICTION LOSSES AND LUBRICATION

Friction losses are dependent upon the character of the bearings, the unit pressures on the bearings and the lubrication. If it were possible to build steering-gears commercially at a price that all would be willing to pay and to use anti-friction bearings throughout, very great improvement in efficiency would result. One of the important reasons for the high efficiency of the cam-and-lever type is the high inside ratio. This increase of ratio always secures a corresponding decrease of internal pressure and, as pressure is a direct factor of friction, lesser friction results. Fig. 8 shows the inside pressures that are produced by varying the length of the steering-arm, for gears of the cam-and-lever and the worm-and-wheel types. It illustrates the advantage of using high inside ratios. As the friction loss is somewhat dependent on the inside ratio, Fig. 8 gives one reason that gears with high inside ratios are more efficient and steer more easily.

It is also easier to lubricate gears that have a smaller proportion of internal friction; and it is also possible to lubricate gears in which the screw or worm or cam is not confined in a companion nut. Screw-and-nut types of gear are difficult to lubricate because the pressure on them squeezes out the oil and the oil does not again get a good opportunity to reach the bearing surfaces until the gear is given a rest. Usually, this is also true in split-nut types, but not to such a great extent. Probably, many have experienced very much easier steering after the car has been given a rest and the oil has had a chance to reach the bearing surfaces.

Aside from the fact that a very great mechanical advantage is not practicable on account of its production of too great a proportion of wheel-turn, if carried to an extreme it would also produce a gear that would be absolutely irreversible.

Vol. XIV June, 1924 No. 6

Automotive Rail-Cars and Their Development

THREE papers treating the subject were presented at the Mid-West Section Meeting held April 11, 1924, at Chicago, and each paper is printed in full herewith. Both the automotive and the railroad standpoints are presented and agree in indicating that the future success of the motor rail-car is assured. The comments and criticisms presented by the automotive and the railroad engineers present at the meeting are significant and optimistic. The general discussion that followed the presentation of the papers brought out additional and valuable information, and it is planned to publish this discussion in full in an early issue.

THE MODERN MOTOR RAIL-CAR

BY M. L. McGREW[1]

BECAUSE of tremendous demand for mass-transportation over long distances in this Country, railroad equipment has become less and less suited for small transportation needs; but a large amount of small-unit transportation exists which can earn a profit for the railroads if they have the equipment best suited to handle it. Gasoline-propelled rail-cars have demonstrated their ability to meet the needs of this small-unit traffic. Types of such rail-cars now operating range from 30-passenger or 10 tons of freight capacity to 60-passenger or 30 tons of freight capacity; in certain services, their capacity can be increased by using trailers and by running them in trains operated by one driver at the front end, who has them under multiple-unit control, at speeds up to 50 m.p.h. and for from 20 to 50 cents per car mile. Recently developed rail-cars are about 55 ft. long, have a useful car-floor area 9 ft. wide, weigh about 60,000 lb. when loaded and require about 1 hp. for each 500 lb. of weight.

Rail-cars propelled by electricity from storage-batteries, by electricity from a gasoline-engine-driven generator through electric motors on the axles and by similar means from power generated by a Diesel engine are mentioned, as well as hydraulic transmissions used instead of electric drive, and cars equipped with large single engines and mechanical transmissions, with comments on their varied performance. Development of multiple-unit control for rail-cars has not presented great difficulties, the main one being sufficient dependability on the power unit for its operation without attendance. This system of control and the mode of synchronous operation of several power units are treated briefly and the rail-car field is surveyed.

Specific rail-car development as reported in the paper includes the reasons governing the determination to use an individual power unit of 60 hp., clutch requirements and design and other elements that can be compounded in various ways to produce rail-cars capable of meeting almost any one requirement. The rail-car design adopted by the company the author represents is analyzed, this being a four-wheel power-truck having an engine and transmission and driving to one axle, as well as gasoline supply, cooling and exhaust systems, an air compressor and an electric generator; a car body suited to the needs of the purchaser; and control equipment, these three elements making possible many combinations to meet specific services, some of which are mentioned. The detail design of the various units is then discussed in sequence.

[1] International Motor Co., New York City.

THIS Country's growth has been due very largely to the tremendous growth of the railroads; they have assisted in opening up new sections to population and development and in the transfer of commodities over long distances. But because the Country has been such a tremendous user of mass transportation over long distances, almost the entire energy and genius of development have gone into the big things of railroads such as the Twentieth Century Limited, the 7000-ton freight-train, the 100-ton-capacity car, the 136-lb. rail and the like. In going after the big end of transportation, the equipment has become less and less suited to small transportation needs; the result is that the user of the small amount of transportation has been going elsewhere for service, and bus and motor-truck services are springing up throughout the Country to take business away from the railroads. Some of this is off-line business or business of such nature that these auxiliary means of transportation can give better service than the railroads could give with any kind of equipment but, in the aggregate, a large amount of this small-unit transportation exists, which can secure a good profit for the railroads, provided they have the right equipment to handle it.

To use antiquated, worn-out equipment is not the economical way to handle small-unit transporation. The operating expense of this equipment is much too high and, in the case of passenger service in most places, the public demands something better than an oil-lighted coach of the vintage of 1870. Gasoline-propelled rail-cars, after 25 years of pioneering, have demonstrated their ability to meet the needs of this small-unit traffic. This development has been slow, because many mistakes have been made in the design and in the utilization of these cars; therefore, the railroads have looked upon the whole development as still in the experimental stage. However, the experimental stage has passed and we will consider the possibilities in this field of light transportation.

TYPES OF RAIL-CAR

Successful units are now on the market of various sizes ranging from a car that can seat 60 passengers or carry 30 tons of freight to a car that can seat 25 passengers or carry 10 tons of freight. Moreover, these cars, in certain kinds of service, can handle trailers to increase their capacity, or they can be run in trains of several cars, using multiple-unit control, and operated

by one driver on the front end. These cars are capable of operating at various speeds up to 50 m.p.h. and, in the case of the passenger equipment, they are furnished in accordance with the highest standard of passenger transportation. These miniature transportation units are designed in accordance with the best practice of modern engineering and are thoroughly dependable. Equipment of this kind can be operated for from 20 to 50 cents per car mile, a figure very much below the cost of equivalent steam transportation.

During the present year, builders have been developing cars that have a useful car-floor area 9 ft. wide and approximately 55 ft. long. Cars of this size weigh 60,000 lb. or more when loaded and require 1 hp. for each 500 lb. of weight; less power than this does not give satisfactory performance, and more power means unnecessarily high operating expense.

Storage-battery cars are in successful operation. Their particular field is where the distances to be run are short and where charging facilities and cheap electric power are available at both ends of a run. They are extremely simple to operate and their mechanical maintenance cost is low, but their high weight, the inefficiency of the batteries and the high cost of battery maintenance and replacement count against them.

Gasoline-electric cars equipped with single large gasoline engines that generate electric power which, in turn, propels the cars by motors geared to the axle, have been used in the past and are again being built. The extreme flexibility of the electric drive is of advantage and has, in the past, attracted several companies into this field. It is understood that cars of this type are again to be offered to the railroads. But gasoline-electric-car advantages are offset because of the great car weight and the inefficiency of transforming the mechanical motion of the engine into electric current and transforming this current back into mechanical motion at the axles. It is also more difficult to find good operators who understand both gasoline engines and electric generators and motors.

The Diesel engine is being used in Europe, where gasoline prices are almost prohibitive, because of its fuel economy. The Diesel engine is primarily a constant-speed engine, but it is always used with an electric drive and the inefficiency of the drive counterbalances the efficiency of the engine. High first cost, great weight and a complicated engine that only a few mechanics in this Country can operate or maintain, offset the advantage of the Diesel engine's low fuel-cost.

Hydraulic transmissions are being used instead of electric drives; they provide the same flexibility and are probably superior in efficiency. The high pressures used to obviate having the cylinders and the pipes of excessive size require extreme accuracy in construction; consequently, they have a high initial cost. It is also believed that these transmissions will prove troublesome to maintain because of the difficulty of preventing leaks.

Cars equipped with large single engines and mechanical transmissions are operating successfully. The company with which I am connected has designed and built one of these, shown in Fig. 1, which is now going through severe operating tests satisfactorily. These cars can be built lighter than any one of the other cars already mentioned; hence, they require less power to equal the performance and carrying capacity of the heavier types and, since their mechanical transmission is highly efficient, these features give this type of car a fundamental advantage over the others. But, in common with the other cars mentioned, they have the disadvantage of requiring engines of higher power than those for which any market exists outside of the rail-car field; this means that quantity production of these engines is impossible and, without quantity production, low price and complete interchangeability of parts are not possible. The clutches and the transmission gears are necessarily much larger than those of motor trucks, and this makes gear-shifting difficult. The solution of the problem lies in the use of two properly synchronized powerplants on each car, so that both can be used simultaneously to propel the car.

Multiple-Unit Control

Developing a multiple-unit control for rail-cars has not presented such great difficulties; in fact, not half as many difficulties exist as in the case of multiple-unit control of subway and elevated trains that have been in successful operation for many years. The real problem of remote control or multiple-unit control for rail-cars has been the matter of having sufficient confidence in the power units so that they could be operated without attendance. The motor-truck engine with which I am most familiar is an absolutely dependable unit that can be left running out of sight and hearing for hours. It is protected by a governor against over-speeding and is provided with a lubricating system that requires no attention other than keeping it filled.

Without dependable units we would not dare speak of the possibilities of multiple-unit control but, with the adoption of the multiple-unit control, several advantageous features have arisen. In the first place engines, transmissions and other parts of the size commonly used in motor-truck operation can be used on rail-cars. This means that the cost of these parts will be kept low, due to the large-quantity production; also, that complete interchangeability will be possible due to the accurate methods of quantity production. A further advantage in the case of the company with which I am connected is that the repair parts for these units are available at almost any population center where a motor truck is used. Another advantage arising from multiple-unit control is the possibility of providing more than one prime-mover per car or per train. This does away with the disadvantage of having to distribute power to more than one axle, provides the advantage of greater flexibility and gives insurance against complete break-downs because, in case of the failure of one unit, it is always possible to come home on the other units.

Synchronous Operation

The matter of successful synchronous operation of several power units has been brought up numerous times lately. This problem presents no difficulty of solution. Our company has had a 30-ton gasoline-locomotive operating for the past 3 years with two powerplants that are driven synchronously. The division of load between the two powerplants is almost equal, depending upon the adjustment of the carbureter. In other words, under certain conditions, one powerplant might be furnishing 48 hp. and the other 52 hp., but this difference is so small as to be immaterial.

Considering the successful rail-car units of the size and the type already mentioned, it does not require much imagination to see the future possibilities in this field. Evidently no excuse can be offered for the continued existence of the two-car or the three-car steam passenger-train. In some places even the four-car and the five-car steam passenger-train might be replaced by gasoline rail-cars. From the character of inquiries that have been

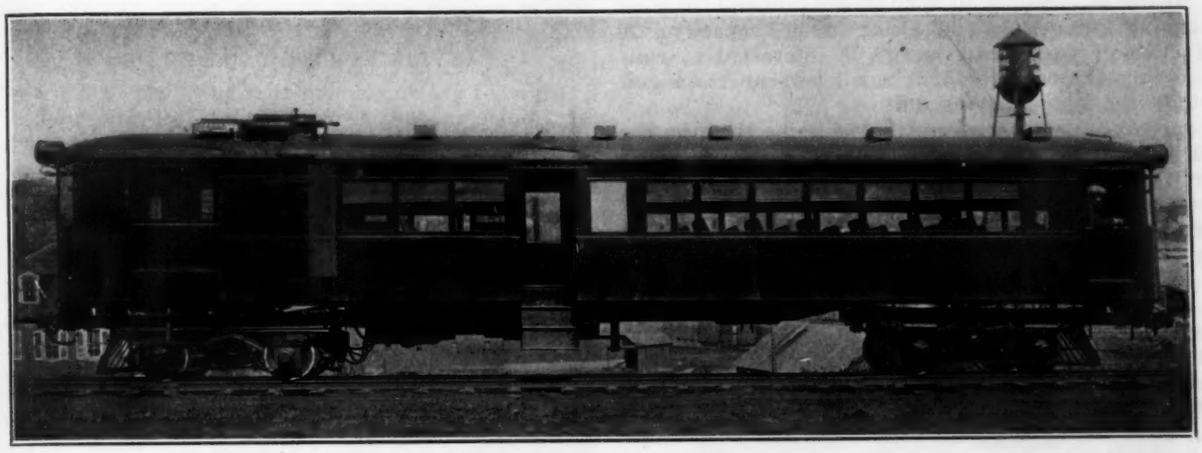


FIG. 1—A RECENTLY DEVELOPED RAIL-CAR

This Car Will Seat 51 Passengers, 12 Being Seated in the Smoking Compartment. It Provides 13½ Ft. of Baggage Space and Is Driven Through Spur Gears by a Six-Cylinder 120-Hp. 5¼ x 7-In. Engine Set Crosswise. The Transmission Is on the Power Axle, Mounted in a Manner Similar to That Used for Street-Car Motors. A Controller of the Type Shown in Fig. 3 Regulates the Engine Speed and the Gears Are Shifted Electro-Pneumatically Through Air Cylinders Having Pistons Connected to the Shaft That Carries the Shifter Forks and the Clutch Lever. Air Admission Is Controlled by a Magnet; the Work Is Done by Air Pressure

made, railroad men are evidently very much alive to these possibilities.

GASOLINE-RAIL-CAR FIELD

The obvious location for the gasoline rail-car is, of course, on the non-paying branch-line where the abandonment of all service is being considered. Rail-cars in these locations have generally paid for themselves in a year or less, partly due to the decrease of operating expense and partly to the increase in traffic that takes place with the use of better equipment. But an equally good location for rail cars, especially for operation in multiple-unit trains, is the in-between and local service on main lines. The profit from the introduction of rail-cars for this service comes from two sources: first, a reduction in operating expenses as compared with the steam train and, second, a saving in the operating expenses of the main-line express-trains, which can make better schedules and will not have to stop so frequently, with an efficient pick-up service operating between principal stations. A third possibility for the gasoline rail-car in multiple-unit trains is in connection with the electrified terminals in large cities. Around these large terminals lies a definite zone beyond which it does not pay to electrify the road on account of the tremendous first cost and the scarcity of traffic; but, beyond the electrified zone, a demand exists for a certain amount of suburban service, say for trains on hourly headway. It is, of course, objectionable to operate by steam into the terminal; on the other hand, it is objectionable to make passengers change to the electric trains at the edge of the electrified zone. Some roads haul the electric equipment with a steam engine for this outer suburban service but this is also objectionable and costly. The gasoline rail-car is ideal for this service, in that it can give a service equivalent to that in the electrified zone and through runs can be made to the terminal without any change of cars.

So far, with very few exceptions, all gasoline-rail-car development has been in the field of passenger service. However, there is no reason why an almost equal field of operation could not be found in the line of transporting freight. The American freight-car is too large a unit of transportation for many conditions; it is ideal for the long-distance mass-transportation in this Country, but the European type of freight car is more suited to much of the local freight service here. Railroads are alive to this condition and are working on various schemes to overcome the difficulty. The container car used by the New York Central Lines is an example of one method; other railroads are adopting the motor truck. Both these ideas are good and should develop a large field of minor transportation.

However, another type of minor transportation exists which the foregoing methods will not take care of, namely, the handling of an occasional carload without breaking bulk; for example, a branch line of some Western road that may originate 2 or 3 carloads of grain per week or the case of some Eastern road that has a branch line on which is located a small industry that receives perhaps 2 carloads of coal per week. A large part of the saving that can be made from the adoption of rail-cars will be lost if it is necessary to maintain steam service to meet these freight situations. While all the development of rail-cars has been in the direction of passenger traffic, no difficulty will be encountered in handling a limited amount of freight traffic. A small gasoline locomotive of about 30 tons can be built to handle the four and five cars necessary in these situations. Moreover, freight-car bodies can be put on the existing type of rail-cars to handle the less-than-carload freight. The way is thus open for the abandonment of steam as a motive power in many places, with the consequent large saving of operating cost. The rail-car has come to stay, without question. Year by year the number of people breaking into the rail-car business has increased, and the number of cars put into service is increasing at a rapid rate every year.

SPECIFIC RAIL-CAR DEVELOPMENT

The ACP type of rail-car is the result of several years of effort and experiment to produce a rail-car that would measure-up to several requirements. In the first place, the scheme of design must be such as to have the flexibility necessary to meet the demand for different types of rail-car of various sizes and powers. The demand for rail-cars as expressed by the various railroad companies calls for a number of different types of car. Some railroads are interested in a very small car that will seat perhaps 30 people, carry a small amount of baggage and provide perhaps over 60 hp. Others are interested in

cars capable of handling 50 to 60 passengers and baggage and having a powerplant of about 100-hp. capacity. A third class of possible customers is interested in rail-cars having the capacity of a small two-car train and about 200 hp. in the driving unit.

It appeared to us very early in the game that the demand for rail-cars of any class would be relatively small at first and that, if any economical design were to be worked out, the same design must be adaptable to all the foregoing demands. The cost of development of this kind of apparatus is very great but, more important than the cost, are the matter of time and the securing of the necessary personnel to take care of development. For these reasons it was seen very clearly that progress could be made in the development of this field only by working-up a design that would be capable of being combined and adapted to the needs of all the various users. After deciding upon the development of an interchangeable universal power-unit, the next question that arose was in regard to the size of this unit and, after some consideration, it was finally decided that 60 hp. constitutes the best size of individual power-unit.

One of the points leading up to this choice was the desirability of applying a drive to not more than one axle of each power unit. The final drive to the axle requires the use of flexible joints to take care of all the various motions that occur between the axle and the frame of the truck. If it is necessary to divide the power from one prime-mover between two axles, the mechanical complications of this flexible drive are considerably increased; this seemed sufficient reason for not making the prime mover of greater power than an amount that could be used on one axle and, after some study, the amount of energy was found to be in the neighborhood of 60 hp. While this statement may be challenged by some of the present builders of rail-cars who are using large prime-movers and distributing power to more than one axle, our reasoning in this matter is well substantiated by the many years of experience of the electric-railway people. Years ago the Westinghouse Company, in connection with the Pittsburgh street railway interests, experimented with the use of large electric motors and power distributed mechanically between two axles, instead of using individual motors on each axle. The theory was that the large motor would be cheaper in first cost and easier to maintain; but the results of these tests proved the opposite, on account of the difficulties with the power-distribution mechanism. Our choice of 60 hp. per axle is also warranted by the experience of the electric railways with cars of the weights we are figuring on in this class of service.

Having determined on the use of separate unit powerplants of about 60 hp. per axle, a large number of other advantages immediately appeared that had not entered into the original consideration. In the first place, 60 hp. is just about the power of the largest-size motor-truck engines. Here was an opportunity for a tremendous saving in cost. Instead of using an engine that is built by expensive hand-methods in quantities of, at most, several hundreds per year, we are able to use engines that are being produced in quantities of thousands per year by the most accurate quantity-production methods. This assures absolute uniformity and interchangeability as well as extremely low cost. After going further into the detail design of this power unit, we found it was also possible to use, with slight modification, standard transmission parts with the same saving as on the engines. Finally, it was found possible to use a large number of other standard motor-truck parts in this design, such as shafts, cooling system, driving gears, clutches and the like.

Clutch Requirements and Design

Clutches are an element that has always been a source of trouble in the development of rail-cars. When the operation of the friction clutch is considered, it will be realized that it is one of the poorest mechanical devices in existence. As a transmitter of energy, a friction clutch at the start has an efficiency of zero; that is, one shaft is rotating and the other is standing still and no power is being transmitted. When the clutch has finished doing its work it has an efficiency of 100 per cent; that is, the driving and the driven shafts are at the same speed and the full torque is being transmitted. Roughly, during the time the clutch is being used for its function of bringing the two shafts to the same speed, its average efficiency might be said to be 50 per cent and the other 50 per cent is therefore wasted in heat or in work such as tearing the friction surfaces to pieces. This 50-per cent component of lost energy in a clutch is not such a serious matter in small clutches, but more attention must be paid to this wasted energy as the amount of power transmitted by the clutch becomes greater. Theoretically, it is possible to design a clutch to transmit any amount of horsepower, provided proper arrangements for cooling and sufficient surface to withstand wear and tear are furnished. This has been done in the case of very large oil engines used on submarines, but such clutches are very expensive in first cost and very heavy and difficult to maintain. The ordinary types of automobile or tractor clutch are not satisfactory when applied to a railroad vehicle and called upon to transmit very large amounts of power. We found this matter of clutches to be one of the important unexpected advantages arising in our ACP design. We are not only using a clutch that has been proved out during many years of use on trucks, but we are not attempting to transmit so much horsepower to our clutch as to require special designs to take care of waste energy.

The ACP Rail-Car Design

This design consists of elements that can be compounded in various ways to produce rail-cars capable of meeting almost any one requirement. The first element consists of a four-wheel power-truck having an engine and transmission and driving to one axle. The power truck is complete in every detail; it has a gasoline-supply system, a cooling system and an exhaust system, as well as an air compressor and an electric generator. The second element consists of a car body that, within certain limitations, may be of any design to suit the needs of the purchaser. The limitations on this body are first, those of weight consistent with the schedules desired and the power available; second, the provision of trap doors at certain points in the floor for the inspection of apparatus on the power truck. Most of the inspection work on the power truck can be accomplished from the ground, but trap doors in the car floor, as shown in Fig. 2, are desirable for some light maintenance work. For heavy maintenance work, it is more practicable to take the power truck out from under the car body. The trap door over the power truck should be approximately 6 ft. long and 30 in. wide, this being no greater in size than the trap door provided in most trolley cars.

Another requirement in the body design is a limitation as to the floor height over the power units. At this point the car floor cannot be much less than 56 in. above the rail. This is not an extreme dimension, as many steam-railroad cars are built with a floor height of 52 in. above

FIG. 2—CAR-FLOOR WITH TRAP-DOOR TO AFFORD ACCESS FOR POWER-TRUCK-APPARATUS INSPECTION
Most Power-Truck Inspection Can Be Accomplished from the Ground, but Trap Doors in the Car Floor Are Desirable for Some Light Maintenance Work. For Heavy Maintenance Work, It Is More Practicable To Remove the Power Truck. The Trap Door Should Be Approximately 6 Ft. Long and 30 In. Wide

the rail, and some interurban cars have floors as high as 56 in. above it. Apart from these limitations, the car-body design may be anything the customer desires as regards the type of construction and the interior design. To meet the requirements as expressed by a number of railroad men, we are now building two sample cars; each has a body 54 ft. long. One is of the center-entrance type, has 26½ ft. of baggage-space and seats for 30 passengers; the other is of end-entrance design, for all-passenger service, and has seats for 60 persons.

CONTROL EQUIPMENT

The third element of the design concerns the control equipment. This control equipment, shown in Fig. 3, is somewhat similar to the equipment used on subway and on elevated-railroad trains. It comprises a controller for the engine, provision for shifting gears and an airbrake valve of the same type as that used on many interurban cars; also an indicating system to furnish the driver with certain indications as to the operation of the power units. The only other equipment necessary on these cars is a storage-battery to go with the generating equipment; it also serves to operate the control as well as the lights.

With these three elements, namely, a power truck, a car body and control equipment, it is possible to make up a large number of combinations. The simplest combination would consist of one power truck, a small car body with a trailer-truck at the other end and one control. This would provide a car similar to the present small rail-cars that we and other companies are building. The car would be able to travel at full speed in either direction but would be controlled at one end only. A second control equipment might be added to this car, to provide for operation from either end. Instead of using a trailer-truck under one end, the car body might be made larger and a power truck might be used under each end. This would give the car double the power of the first one and afford control from either end. This is the type of car we are now building.

By installing the necessary train-line coupler-connections at the ends of such a car, it would be possible to couple two or more similar cars together to form a multiple-unit train, each car having its own power units but all operated from any control position on the train in the same manner as on subway or elevated lines. Other variations of these combinations are possible; for instance, trailer cars without power but provided with control equipment might be used in conjunction with power units to form a train that could be operated from either end but that would have less power and be less costly than a train made up of cars each having its own power unit. It has moreover been found possible, although the detail designs have not yet been made, to provide a four-wheel power-truck having two powerplants, thus making a power unit double the size of the one we have now developed. No great demand for such a unit exists in the straight rail-car field, but a possibility for such a unit will be found in the development of a small locomotive to handle light-freight work on branch lines where the passenger service is handled by rail-cars.

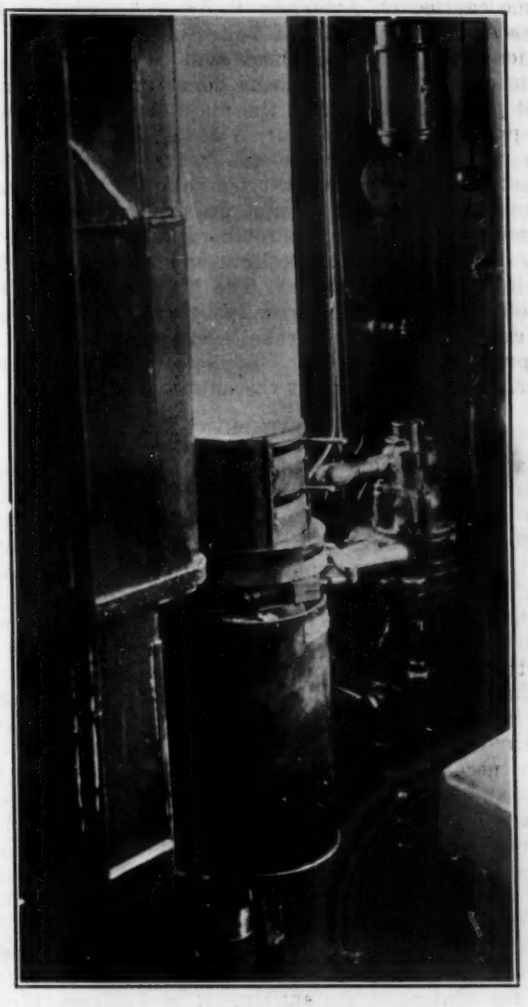


FIG. 3—CONTROL EQUIPMENT FOR RAIL CARS
It Is Somewhat Similar to the Control Equipment Used on Subway and on Elevated Railroad-Trains, Comprising a Controller for the Engine, Provision for Shifting Gears, an Airbrake Valve of the Same Type as That Used on Many Interurban Cars and An Indicating System To Furnish the Driver with Certain Indications as to the Operation of the Power Units. The Storage-Battery That Accompanies the Generating Equipment Serves Also To Operate the Control and Supplies Current for the Lights

In addition to the great flexibility in the combination of power units, car bodies and control, it is possible to

secure further flexibility by variations in the final driving-gear ratio on the power units. A power unit can be built which will have a maximum safe operating speed of 60 m.p.h. or of 30 m.p.h. with corresponding differences in the tractive efforts available. The road that wants high-speed service would use a high-speed unit and would not attempt to operate trailers. The road that has heavy grades or the road that is satisfied to give slow-schedule speeds and use a trailer will employ a slow-speed unit. Moreover, the change in gear ratio is an operation that is easily performed in not more than 4 or 5 hr.

Detail Design of the Various Units

The truck design consists of a pressed-steel riveted frame carried on American Railway Association 4¼-in. Class-A axles having 3¾ x 7-in. American Railway Association journals. The wheels will be of rolled steel, 30 in. in diameter. The journal boxes are carried in cast-steel pedestals riveted to the main frame. Coil springs are provided over the journal boxes. A cast-steel transom tieing the two truck side-frames together supports a cast-steel bolster on two semi-elliptic bolster-springs. A foundation brake of simple design for a body-mounted cylinder is furnished to provide a total brakeshoe pressure of 85 per cent on the light weight with a 50 lb. per sq. in. cylinder pressure. The bolster of the truck is set off-center so as to throw two-thirds of the weight on the driving axle. The brake leverage provides for similar proportion in braking. A pilot will be furnished, one attached to each truck at the outside end.

Powerplant

Each truck will be furnished with a powerplant, mounted on the truck; it consists of our AC 5 x 6-in. four-cylinder engine capable of developing a maximum of 60 hp. Through a dry-disc clutch and a universal-joint, this engine is connected to a transmission that, in turn, is connected through a universal-joint to the gears on the driving axle. These drive gears consist of a dual reduction in which the drive is connected to a bevel gearing that is, in turn, connected to spur gearing mounted on the axle. Provision is made at this point for several different gear-ratios, depending on the service in which the car is to be placed. The engine is equipped with the other necessary auxiliaries, all mounted on the same truck and consisting of a cooling system, a gasoline-supply and an exhaust system. From a power take-off gear mounted on the transmission, provision is made for the air compressor. The air compressor is a 3½ x 4-in. size that delivers 10 cu. ft. per min. when running normally at 378 r.p.m.

For these rail-cars, the control consists of several parts. First, we provide for control of the engine; second, for control of the shifting of gears; and third, for control of the auxiliaries.

Control of the engine is secured electrically through an electric controller at each operating position. By this controller a circuit is energized which closes a relay that puts the ignition system into operating condition. This circuit remains energized all the time the engine is running and, in case of failure of this circuit, the engine will stop. A second circuit from the controller is energized and closes a relay that supplies electricity to the starting motors of the engine; this provides for cranking the engine when starting. Three other circuits from the controller provide, by magnets, for moving the engine throttle to a number of different positions, thus giving control over the power output. Two additional circuits from the controller provide for the adjustment of the points of ignition by advancing or retarding the magneto. A return circuit from each engine to each controller shows, by a light indication to the operator, that the ignition circuit is energized, that the engine is running and approximately how fast.

Control of the Shifting of Gears

The control of the shifting of the gears is accomplished electro-pneumatically. The actual shifting of the gears is accomplished by air cylinders, the pistons of which are connected to the shafts that carry the shifter forks and the clutch lever. The various movements are interlocked against each other mechanically so that, even in case of failure of the electric or the air equipment, it is impossible to damage the transmission. The admission of air to the operating cylinders is secured by electrically operated valves. The control of these valves is secured by nine circuits from the controller; they are capable of providing for the operation of the car in four speeds forward and four speeds reverse, as well as for operating the car in neutral when coasting. The air supply for this control equipment is taken from the airbrake system through a special reducing-valve that provides reduced pressure. A special reservoir, protected by a check valve, is carried on each truck to act as a reserve supply in case of the failure of the hose connection between the car body and the truck.

Control of Auxiliaries

Provision is made in the electrical control for certain auxiliary functions. Means are provided for holding the clutch out temporarily while coasting, but without shifting gears; for operating the sanders that are mounted on the trucks; and for operating a signal buzzer at each control position.

In all the foregoing controls, reference is made to the control of only one unit; but, as all of these controls are automatic in operation, it is possible to operate more than one in parallel and this will be the case on a single car having two power units. It is, of course, possible to operate two or more cars in parallel, thus furnishing multiple-unit operation. Receptacles and jumpers will be provided for operating the car in multiple with others. It is also possible to cut-out one or more power units at any time.

In connection with the control equipment on these cars, and particularly with regard to the mechanical part of the transmission and control: The transmission consists essentially of a standard motor-truck gearbox of the type we use on our largest trucks and which is amply designed to carry the load; and the shafts and the gears and the bearings used in this transmission are all interchangeable with truck parts that are carried in all our service-stations. The case, however, is of special design and provides some features not found in a motor-truck transmission; in it, ahead of the main transmission-gearing, we provide a spline shaft on which two sliding gears are mounted. The drive from the engine comes through the clutch to this spline shaft first and, by these sliding gears, either the countershaft or the main shaft of the transmission can be driven. This provides for reversing the drive and, at the same time, for utilizing all four speeds in either direction. The remainder of the gears and the shafts in the box are similar to those in the truck transmission and provide four gear-ratios with a direct drive to the fourth.

The shifting of these various gears, that is, the reversing gears on the short spline-shaft and the ratio

gears on the main shaft, is accomplished by air cylinders connected to rods that carry shifter forks in the usual manner. In addition, a rod that operates across the former rods and acts as a lock on the gears when they are shifted is provided. This interlock is equipped with a number of keys that match-up with notches on the shifter rods, and the interlock rod is connected to an electrical interlock switch that has an important function in the control. The mechanical function of this interlock rod is to prevent the shifting of any gears until the interlock rod and its attached switch are in the "out" position; and, conversely, the interlock rod and its attached switch cannot go into the "in" position until the gears are shifted all the way home. This rod performs a further function of locking the gears in mesh so that it is possible, after the gears are shifted, to release the air from the cylinders and thereby save the loss of air.

In addition to this mechanical interlock, a small rocking interlock is located between the shift rod for the first and second gears and the shift rod for the third and fourth gears. This rocking interlock merely prevents any possibility of moving one shifter while the other is in any other than the neutral position. This is merely for extra protection, as it is only possible to have such an occurrence if two electrical failures should occur at the same time. The control of the gear shifting and the synchronizing of this control between several power units is secured by this mechanical interlock and a small electrical relay that is mounted in a cabinet on the side of the truck.

The operation of the relay is as follows: As soon as the driver presses down on the handle of the controller so as to move it from notch to notch, the circuit through the relay is closed and this puts the relay in the "in" position. This relay then remains in the "in" position until all the gears in all transmissions have come to neutral. The gears are brought to neutral as soon as the mechanical interlock is moved out by centering springs on the gear-shifter shafts. After all the gears in all transmissions have come to neutral and if by that time the driver has released the latch on the controller in the new notch to which he desires to shift, the relay then drops out and thereby establishes the circuit for operating the shifter valve on the air cylinder to throw the proper gear into mesh. When all these gears are in mesh and the interlock is in place, locking them in, the circuit is then broken; this permits the clutch to come in. It will be seen from the foregoing that the gear shifting on a number of power trucks is synchronized perfectly.

This synchronizing operation has three steps: First, the bringing of the gears to the neutral position that includes, of course, first throwing the clutch out; second, the shifting of the gears into the new position; and third, allowing the clutch to come in again. Each of these operations must be complete on all trucks before the succeeding operation can start.

As to synchronous operation of the power units, the various engines on the different power trucks that drive a car are all connected together mechanically through the track and, therefore, will run at the same speed. In case the wheels should slip on any one truck, the governor on that engine will prevent the engine from racing, or running away. The control of the throttle on these cars, as well as the control of the spark position, is secured by three magnets that are connected together so that the plunger of one magnet adds its pull to the plunger of the next magnet and so on. The first magnet is made with an air-gap of ⅛ in., the second has an air-gap of ¼ in. and the third an air-gap of ½ in. By combining the pull of one or more of these magnets it is possible to secure a motion from zero to ⅞ in., advancing by eighths of an inch. This provides eight definite positions of throttle control which will be the same on all engines. The division of power between gasoline engines driving the same load and running at the same speed with identical throttle settings will divide up on an almost equal basis, depending on such minor matters as carbureter setting, condition of the engine, amount of compression and the like. The difference between any two engines is not likely to be more than from 5 to 10 per cent.

Engine-Performance Indication

One other feature provided on these cars is the return indication to the driver, from the engine, of the engine performance. On each engine a contact device is driven from the camshaft, which makes a contact every revolution of the camshaft or every other revolution of the engine. These contact devices on each engine are connected to different supply wires in the train line, which connect to indicator lamps at the driver's positions. The current for these circuits is taken from the same current supply that is provided for the ignition of the engine. It is evident, therefore, that these indicator lamps will flash every other revolution of each engine and that they will indicate to the driver the approximate speed at which the engines are running, whether the wheels are slipping on any unit and whether the ignition circuit is operating properly.

Car Bodies

The third element in the various combinations is the car body. The design of this element can be made almost anything to satisfy the requirements of the railroad. It is not necessary to make very much comment on this design, as the users of rail-cars are more familiar with their own needs than we might be. The series of rail-cars we are bringing through now is designed with the very best equipment; the cars have high-grade standard railroad-car seats, shown in Fig. 4, and are provided with vestibules, saloons, high-grade train-lighting equipment and hot-air heat. In choosing equipment for these cars, it is important to select light-weight equipment so far as possible, for it should always be kept in mind that a rail-car has a limited amount of power available and that

Fig. 4—Present Car-Body Design and Equipment
Rail-Cars Now Being Built Have High-Grade Standard Railroad-Car Seats and Are Provided with Vestibules, Saloons, High-Grade Train-Lighting Equipment and Hot-Air Heat. Light-Weight Equipment for These Cars Is Desirable, because a Rail-Car Has a Limited Amount of Power Available and Every Pound of Reduction in the Weight of the Equipment Represents an Additional Pound of Pay-Load That Can Be Carried, but Extremes of Light Weight of Such Equipment Should Be Avoided

every pound of reduction in the weight of the equipment means an additional pound of pay-load that can be carried. However, in lessening the weight of the equipment, no reason exists for going to the extremes that some builders have adopted and for using equipment that will not give service. For example, some of the seats on the market, such as are used in motorbuses, have been applied on some rail-cars; but they will not withstand the ordinary wear and tear of railroad usage. Likewise, no reason can be urged against making the lighting, heating and ventilating equipment of these rail-cars as good in every way as that provided for the best railroad service.

MOTORIZED RAILROAD EQUIPMENT

BY E. J. BRENNAN[2]

A BRIEF summary of the history of motor rail-car equipment on the railroad represented by the author is given in his paper. Three gasoline-driven rail-cars were put into operation in 1910. The engine used for each car was a six-cylinder, 10 x 12-in., slow-speed, four-cycle reversible-type having overhead valves, an open crankcase and a 200-hp. rating, but experience has proved that the four-cycle reversible-type engine equipped with an air-operated starting-apparatus makes rather a complicated unit that is the cause of many difficulties. Details are given concerning these first three cars, their performance and the changes made in their equipment.

In 1922, a two-car train consisting of a motorcoach and a trailer was installed. The coach is 28 ft. long, has a 12-ft. baggage-space, carries 30 passengers and weighs 28,000 lb.; the trailer is 32 ft. long, weighs 17,000 lb. and seats 36 passengers. Equipped at first with a four-cylinder 65-hp. engine, this was found to be of insufficient capacity and a six-cylinder 105-hp. engine was substituted. Other changes have been made since and these are specified. Experience with the rail-cars thus far specified showed that any future units, and particularly two-car trains, must be of light construction and of sufficient ruggedness to operate on steam-railroad lines.

The next installation was a single-unit rail-car weighing 30,000 lb. and having capacity for 38 passengers. It has a 65-hp. four-cylinder engine and operates very successfully over a daily 185-mile run through level territory. After inaugurating a new set of motor rail-car stations at public-highway crossings along this route, passenger business for this particular unit increased.

A train consisting of a large motorcoach and a trailer, powered with a 225-hr. marine-type engine, was then installed and operated over a 216-mile route. The coach seats 30 passengers and has a 16-ft. baggage-space; the trailer seats 44 passengers. These gasoline-propelled rail-cars and trains are driven by steam-railroad engineers. The last-mentioned train has operated so successfully that the company has ordered two more similar trains of even larger capacity and, in addition, a gasoline-electric single-unit rail-car. The operating and maintenance costs of the equipment mentioned are tabulated.

Some general requisites for stability, reliability and low total costs for rail-car utilization are that an engine of sufficient capacity be provided to enable it to operate normally at not more than 60 or 65 per cent of its maximum power; that lighting arrangement, current generation and current storage be improved; that passengers be made more comfortable; that the cooling capacity be made ample for the engine; that U. S. Standard and not S. A. E. Standard bolts and nuts be used; that all parts be made accessible and that parts be standardized.

MOTOR rail-car equipment was first installed by the company I represent in 1910. In that year it placed in revenue service three gasoline-driven rail-cars, Nos. 1000, 1001 and 1002. These cars, one of which is shown in Fig. 5, were equipped with what is known as the type-A engine that is rated as a 200-hp, six-cylinder, 10 x 12-in. slow-speed reversible four-cycle engine having overhead valves and an open crankcase. The engines on all rail-cars of this make, regardless of the type, are located on the front driving-truck and are bolted and riveted to the truck frame. Our experience with these cars has developed that the four-cycle reversible-type of engine was and is the direct cause of many difficulties, owing to the fact that twice as many points of wear in the camshafts and timing arrangements are present; and this fact, together with the inclusion of an air-operated starting-apparatus, makes rather a complicated unit. The ignition system consists of a high-tension magneto of special design, constructed to run in either direction, and a timer having six vibrating coils and using either storage batteries or dry cells. The carbureter is located in the center of the engine and has long intake-manifolds.

A sprocket wheel is located in the center of the crankshaft; from it a 4-in. silent chain carries the power to the clutch and the transmission located on the driving axle. Only low and direct speeds are used and, as the engine is reversible, they are used in either direction the car is operated. When necessary to resort to the reverse motion, a requirement frequently experienced on a single-track railroad, it is necessary to stop the engine and start it in the reverse direction. The ordinary air-compressing equipment has been found inadequate, owing to the heavy demands made on compressors in present-day service in that frequent highway-crossing signals must be sounded with the air-whistle; this seriously depletes the supply of air and causes delay, until the pressure is restored, in turning the engine over in the reverse motion. The auxiliary air-compressor, which is a combined gas engine and air-pump, is a part of the equipment and does what we consider a fair job when the compressor and engine are in first-class mechanical operating-condition. The foregoing gives an idea of some of the complications that have been experienced with this type of equipment.

Performance of First Rail-Car Equipment

On motor rail-car No. 1000 we installed, in 1915, a type-C engine that differs somewhat from the type-A engine in that it is a T-head engine having a greater water-cooling capacity around the cylinders and the valves. This type-C engine also has a closed crankcase and is equipped with the splash system of oiling. On the type-A engine, each bearing is lubricated through an oil-pipe from a 14-feed mechanically operated lubricator, in contrast to the splash system of oiling the type-C engine. The intricacy of such mechanism in railroad service can be appreciated readily, the equipment being too easily damaged or broken so as to cause hot bearings. This is especially true in localities where the railroad companies are obliged to use gasoline-driven cars on branch lines not equipped with shop facilities to inspect and give at-

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tention to such parts at frequent intervals. Considerable reductions in maintenance costs have been realized through the use of the type-C engine in preference to the type-A engine, because the general design is more simple and it is constructed to withstand the service for which it was built better than the type-A engine can, but it is necessary that first-class workmanship be done on the connecting-rods and the crankshaft bearings so that the full benefit can be realized from the type-C engine in this respect. We determined that the type-C engine operated at the very high compression of approximately 6 1/3 atmospheres and, when being used on grades or for pulling a trailer, it was very noisy and caused some discomfort to the passengers. Brass rings 7/8 in. thick were applied under the cylinder-head; this reduces preignition, eliminates feeding so much water and, in consequence, increases the power with a corresponding reduction in fuel. This change reduced the compression to approximately 4 7/8 atmospheres.

On motor rail-car No. 1001 we have applied individual kerosene carbureters for each cylinder. These are much more flexible and the car performs better because the engine can be balanced and a more even torque obtained than with the standard equipment. These cars operate for about 35 cents per mile, total operating and maintenance costs, except motor-rail car No. 1000 that, in regular service, pulls a 35-ft. trailer for mail and express. This two-car unit average cost is 40.14 cents per mile.

The coach of this type of rail-car is well-constructed and built to overcome wind resistance. The body proper is 72 ft. long and has a seating capacity of 83 passengers. The heating of the car is accomplished by coils heated from the engine but, owing to the fact that we operate these cars in Minnesota where the climate is rather cold we have, as a measure of safety, installed coal-burning stoves for use whenever it becomes necessary to stop the engine. The weight of this type of rail-car, empty, is approximately 35 tons.

Our everyday encounter with the foregoing details encouraged the use of a lighter, more flexible unit; a unit of sufficient stability to be operated in the same service, yet simple enough so that, where they are used in branch-line service, the average mechanic or engineer can make minor repairs successfully and keep the cars away from the repair shops for a longer period.

Two-Car Train Equipment and Performance

Our next addition of gasoline-driven equipment was the installation on our line of a two-car train consisting of a motor rail-coach and a trailer. It was placed in service in the early part of 1922. The motorcoach of this train is 28 ft. long, has a 12-ft. baggage space, carries 30 passengers and weighs 28,000 lb. The trailer is 32 ft. long, weighs 17,000 lb. and has a seating capacity of 36 passengers. In the development of this train, the railroad engineers cooperated with the automotive engineers and were governed in large measure by their advice. This train was equipped originally with a four-cylinder 65-hp. engine, but it needed only a trial trip to prove that the engine was not of sufficient capacity, and a six-cylinder 105-hp. engine was substituted at once. After this change was made and the train had been placed in revenue service, we found that the radiation supplied for the 65-hp. engine was not sufficient for the 105-hp. engine and that the drive was not substantial enough. Frequent changes have been made in this unit and, at present, we are installing heavier shafts and joints of more than double the strength of the original equipment,

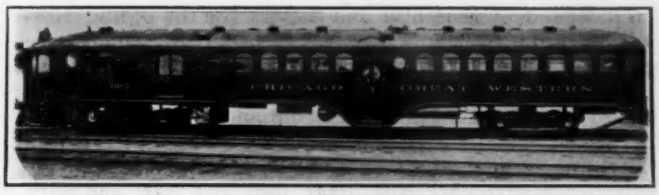

Fig. 5—Type of Rail-Car First Installed, in 1910

This Type Was Equipped with a 200-Hp., Six-Cylinder, Slow-Speed, Reversible, Four-Cycle Engine, Having Overhead Valves and an Open Crankcase. It Was Located on the Front Driving Truck and Bolted and Riveted to the Truck Frame. The Coach of This Type of Rail-Car is 72 Ft. Long and Has a Seating Capacity of 83 Passengers. Its Weight, Empty, is About 35 Tons. Later Changes Included Installation of an Engine Having a Closed Crankcase and Splash Lubrication

with the expectation that we will derive greater benefit therefrom. The original trucks under this first gasoline-driven train were equipped with ball bearings of sufficient capacity to carry the load but not having adequate strength to withstand the frequent severe shocks of striking rail-joints, crossings and the like which are encountered in railroad service. We found that the balls would chip; this would lock the bearings, cause the axle to turn and result in failure. Also, the trucks were rigid and caused undue vibration; regardless of how we bolted the various appurtenances to the trucks, they would invariable shake loose. All this, coupled with frequent complaints from the passengers regarding poor riding qualities, made it necessary to change the design and this was done.

The original oiling system apparently was of sufficient capacity for commercial use, but it would not supply the engine and the bearings properly on the scheduled runs in railroad service. This made it necessary to install a larger oil-pump that produces a pressure of about 40 lb. per sq. in. on the crankshaft at full speed. With the original oiling system, we experienced an average of one connecting-rod failure each week; but, since the oiling system has been increased to have a greater capacity, we have experienced periods of 4 months before it became necessary to remove even a very thin shim.

This two-car train operates between McIntire and Waterloo, Iowa, and makes the round trip every day, a distance of 184 miles. Between Oelwein and Waterloo, a distance of 26½ miles, with three intermediate stops required, the schedule time is 50 min.; the train accomplishes this daily without any apparent trouble. The heating system in the motorcoach is supplied from the exhaust of the engine, but the trailer is heated by a hot-water circulating system. The original starting and lighting systems were connected to the same storage-battery and, during the layover period at night when the train was being cleaned and the lights were used for even a short period, the battery would become exhausted to a point at which not enough energy was left to operate the starter. To overcome this, we installed

Fig. 6—Motorcoach M-205 and Trailer MT-206

The Coach Has a 225-Hp. Marine-Type Engine, Seats for 30 Passengers and a 16-Ft. Baggage-Space. The Trailer Seats 44 Passengers. This Train Is Operated 216 Miles Per Day, Very Successfully

an independent generator and battery for the lights. Notwithstanding the many features in this train which were really of an experimental nature and needed additional engineering, we were not discouraged. We continued to improve and strengthen the equipment as weaknesses developed, and our records indicate that this train is operating now at a cost of about 28 cents per mile. Our experience with cars Nos. 1000, 1001 and 1002 and with the subsequent two-car train taught us that any future units, particularly two-car trains, must be of light consruction and of sufficient ruggedness to operate on steam-raliroad lines.

Single-Unit Rail-Car of 1922

Our next addition of gasoline-driven equipment was our single-unit rail-car, M-400. This car weighs about 30,000 lb., has a seating capacity of 58 passengers and is equipped with a special 4¾ x 6-in. four-cylinder engine that develops approximately 65 hp. This car is being used very successfully on what we consider a light run; it operates between Shannon City, Iowa, and St. Joseph, Mo., and makes the round trip of 185.2 miles every day. To date, this car has operated a total of more than 60,000 miles without receiving a thorough overhauling, but it must be overhauled before another 5000 miles of running is completed. This unit operates very successfully in the service to which it is assigned; the territory is level and the schedule is slow. While the number of miles run per day is equivalent to the mileage made by the two-car train between McIntire and Waterloo, Iowa, the service is not nearly so severe.

The M-400 car stops and starts with very little delay. Owing to this, we have inaugurated a new set of motor rail-car stations at public highway crossings. This has been the means of increasing the passenger business for this particular unit and it has gained considerable popularity among the residents along the route. The drive of this unit is in reality to all four wheels of the front truck, using fabric joints. A difference of opinion with reference to the shock-absorbing characteristics of these joints seems to exist but, regardless of this, we have experienced no trouble with the transmission assembly on this car. In the event that the schedule or running time of this car were shortened or the service made more severe, some refinements would have to be made to reduce the maintenance cost.

Two-Car Train of 1923

The service to which the two-car train of 1922 was assigned became rather popular with the traveling public and we soon felt the need of having a train of greater capacity. We then developed a larger motorcoach and trailer and in July, 1923, we installed motorcoach M-205 and trailer MT-206 shown in Fig. 6. The motorcoach has a 225-hp. marine-type engine equipped, so far as we know, with every late modern improvement. It has seating capacity for 30 passengers and a 16-ft. baggage space. The trailer seats 44 passengers and is equipped with reversible seats, thus avoiding the necessity of turning the trailer. This train is operated daily between Waterloo and Des Moines, Iowa, a distance of 216 miles per day, and has proved to be a very successful venture as compared with our previous experience. Many refinements were incorporated in this train from experience gained with our former units of equipment. We have long since demonstrated that gasoline equipment designed and built for commercial service will not give the best results in railroad service; the parts throughout the equipment generally must be more rugged in construction to operate successfully and at a conservative cost. This condition must obtain necessarily, owing to the fact that the same operator is not with the equipment every day.

Our gasoline-driven trains are handled by our steam engineers who have spent the best part of their lives operating steam locomotives in railroad service. Owing to the rules and the agreements between the company and the men, changes in the personnel of the crew occur which will not be advantageous to the economical performance of the train until a thorough working knowledge of the various units of equipment is obtained by the men to whose lot it falls to operate these machines.

The train shown in Fig. 6 has operated so successfully that we have ordered two more trains of larger capacity which have been somewhat refined in detail, compared with the present equipment, but not in the general design. A few minor defects have been developed in service, but they are corrected as they occur. Redesigning is done to overcome the objectionable features permanently. Our statistics indicate that the train made up of cars M-205 and MT-206 is operated at an average cost of 24.89 cents per mile, including operating and maintenance costs.

In addition, we have ordered a gasoline-electric single-unit car that will be delivered to us soon. This indicates the extent to which our company has gone into the use of motorized equipment to reduce its operating costs further and to develop from actual experience the best type and style of equipment for accomplishing this result. Table 1 presents interesting information from our records regarding the costs to operate the various units of equipment.

TABLE 1—GASOLINE RAIL-CAR OPERATING COSTS

		Two-Car Unit			Single-Car Unit		
Car Designation		M-200 M-201	M-205 MT-206	No. 1000 No. 1025	M-400	No. 1001	No. 1003
Engine Type		.....	.....	*B*	.....	*A*	*C*
Period Covered	From	October, 1922	August, 1923	May, 1923	November, 1922	October, 1922	July, 1923
	To	December, 1923	January, 1924	December, 1923	January, 1924	December, 1923	December, 1923
Total Cost Per Mile, Cents		27.29	24.89	40.14	24.71	35.93	24.86
Gasoline Consumption, Miles Per Gal.		4.72	2.44	1.41	5.47	1.88	2.19
Oil Consumption, Miles Per Pt.		15.72	17.12	2.95	17.52	8.78	4.74
Total Train or Car Mileage		36,776	30,587	17,570	54,252	45,006	24,763

Requisites for Stability, Reliability and Low Operating Cost

In connection with our experience with the gasoline-propelled cars, it is well to mention a few requisites for stability, reliability and low operating and maintenance costs. First, an engine of sufficient capacity should be installed so that it will not be required to exert more than 60 or 65 per cent of its power except in cases of emergency. For obvious reasons, the builder applies to his engine a rated horsepower and in the preceding paragraphs we have given the ratings applied by the builder; but in actual experience the engines do not develop the

horsepower rating applied nor would it be safe or economical to permit them to perform regularly at a speed that would produce the rated horsepower. As an illustration, we refer to the engines of cars as being of 200-hp. capacity when, as a matter of fact, at 450 r.p.m., equivalent to 40 m.p.h., we get a maximum of 182 hp. With the marine-type engine for motorcoach M-205 we have found a safe, consistent speed for this engine in steam-railroad service to be approximately 1125 r.p.m., equivalent to 50 m.p.h. and, at this rate, it develops 165 hp., although it is rated at 225 hp. It is well that these facts be borne in mind in the future development of motorized equipment for steam railroads.

The matter of lighting arrangement and equipment has not been mentioned, but considerable room for improvement generally with respect to these two necessities exists. Some of the original installations of lighting fixtures followed automotive practice and used the bayonet type of lamp, but we found them unsatisfactory and had to resort to the use of the standard Edison-base lamp. The present system of current generation and storage, in our opinion, could be improved materially through the use of an axle lighting-equipment; and it is our thought that a device of this character consistent with the size and the type of gasoline-propelled cars used on steam railroads must be developed. Such an axle lighting-device could be attached to the motor rail-car, and the trailers illuminated through train-line connectors. We have found the center type of lighting to be the most practicable and economical, compared with the side illumination; and that 25-watt 30-volt lamps give us the best service.

General Recommendations

The comfort of the passengers is a very important requisite. The cooling capacity provided for the engine must be ample. Wherever possible, all bolts and nuts throughout the entire equipment should be U. S. Standard instead of S. A. E. Standard. All railroad shops are stocked with U. S. Standard parts and the railroad engineers do not wish to have another standard introduced into rail-car practice. By adhering to the U. S. Standard, the stock of utility parts decreases about 12 per cent. Also the possibility of error in mixing nuts and bolts when the repairs are made by the class of help generally found in railroad yards is to be considered.

Accessibility is essential and the standardization of parts is very important so that the number of parts carried in stock can be reduced as much as possible. This is necessary also on account of conditions arising which necessitate moving the units from one division to another; in this event, the fewer the spare parts are that must be carried in stock, the smaller the amount of money tied-up will be.

When the gasoline-driven equipment is to be assigned regularly to a branch line, the engine should have sufficient capacity to handle the equipment for which it was designed and, in addition, a box car or a coach, even though this be accomplished at a greatly reduced speed. Experience has taught us that this is necessary.

MOTORIZATION OF "LIGHT-SERVICE" RAIL-TRANSPORTATION

BY E. WANAMAKER[3]

ASSIGNING the cause of failure to develop railroad light main-line and branch-line transportation satisfactorily as having been the necessity of concentration by railroad officials on the problem of moving heavy transportation-units over long distances, and stating that a general acknowledgment has been made by all concerned that the steam locomotive for railroad light-service traffic has proved to be unsatisfactory, the author discusses the types of internal-combustion-engine power-units best suited for rail-car propulsion.

Three prime requisites to the development of such equipment are economical production, economical operation and a high quality of service rendered. No particular benefit will be derived from introducing internal-combustion-engine drive to railroad service by making minor improvements to such equipment as has been built for other services; rather, it is necessary that engineers work along the lines of radical changes and radically new developments.

For economic reasons, two types of internal-combustion-engine-driven rail-cars should be standardized, one of about 60-hp. and the other of about 300-hp. power-unit capacity. The former would use gasoline as fuel; the latter, the type of fuel suited to Diesel engines.

The use of such standardized commercial engines, of limited horsepower but installed in multiple in a given rail-car, would provide a satisfactory system. Engines, clutches and transmissions of approximately the 60-hp. size have been developed to a satisfactory degree for the heaviest and hardest truck-service and, with the intelligent mounting of these engines and units on a rail-car or on a light locomotive truck, together with a suitable multiple-unit-control system, the successful solution of the rail-car problem for all except the heaviest class of light-service traffic is offered.

Differing radically from the 60-hp. powerplant, the 300-hp. unit would be driven by the latest type four-cycle multi-cylinder Diesel engine at an engine speed not to exceed 650 r.p.m. It would use a system of fuel injection and distribution that would eliminate high-pressure-air-piping, the spray air-bottle and similar parts; would operate at constant speed and depend upon electrical transmission to satisfy the variable torque and speed requirements of the locomotive. Primarily, it would be used as a locomotive, flexibility as regards capacity being secured by using any desired number of generators and motors in multiple, in one or more rail-car units.

THE vast area of the United States and the settlement methods by which our Country has been developed necessitated railroad development such as we have had. Built-up in the face of obstacles to the efficient transportation that has been furnished, I feel that our citizenry fails to appreciate the wonderful development of our rail transportation. It is possible that this lack of appreciation is due to the fact that the railroad officials have been so busily engaged in building-up and maintaining such service that they have had no time to keep the public informed as to the growth and the value of our rail-transportation-system; therefore, it seems that each individual who understands the situation should advocate that the railroads be given the opportunity to continue their development. Large area,

[3] Electrical engineer, Chicago, Rock Island & Pacific Railway Co.

together with the great diversity in topography and in the character of the industries of the Country, called for railroad development such as has not been called for elsewhere. It has been necessary for the railroad officials to concentrate on the movement of heavy units over long distances, and they have successfully solved this problem that has to do with by far the greatest percentage of the railroad business of transportation. Further, railroad managers are keeping the problem of the movement of heavy tonnage over long distances solved uptodate.

Railroad managements, contrary to what many people think, understand and know full well that they have not been able to handle the light main-line and the branch-line traffic satisfactorily, but they have handled it as well as was possible with the available equipment, not only for the welfare of the railroad but for the welfare of the public served. The classified light-service traffic is such a small percentage of the total railroad business that the always limited funds of the managements have compelled them to concentrate on the major percentage, the heavy traffic. Likewise, the producers of equipment have been compelled to work on developments such as offered them a sufficient market to recover their expenditures for research and development, plus a fair margin of profit. It is true that the railroad managers and some producers have tried to crowd-in some study and development work; but they have always been handicapped by insufficient funds and lack of time, the result being that they have only been able to make some minor improvements, constituting say from 2 to 5 per cent of those needed. So far as was possible, these were made by adapting to railroad service equipment built for other than railroad service; but such feeble attempts can produce feeble results only, in regard to ultimate success.

General acknowledgment has been made by all concerned that the steam locomotive for railroad light-service traffic has proved to be uneconomical and unsatisfactory; hence, the eyes of the railroad managements have turned longingly to the possibilities of the internal-combustion-engine drive as the ultimate solution. It is true that electric-storage-battery rail-cars can be used satisfactorily and economically within a limited field, and that in another limited field straight electric cars can be used to advantage, but the internal-combustion-engine drive seems to offer a far more favorable solution for the major portion of the light-traffic field in its entirety.

Bearing these known conditions in mind, let us concentrate on such a method of furnishing light-traffic rail-transportation. We should not forget the value of the motor truck and the motorbus as adjuncts to rail service, but our first concern is our rail service, as we now have the rails and all facilities in connection therewith. The gradual development of the highway motor-truck and motorbus service is dependent upon highway developments; and the development will be made gradually by railroad companies or others, or a combination of both, as individual cases justify, provided the railroad managements lend their best cooperative efforts to such development.

After 10 years of study and experience as regards the adaptation of internal-combustion-engine drive to railroad service, I feel strongly that such a drive offers most acceptable possibilities, but that we are not to derive any particular benefit from such a drive by making minor improvements to such equipment as has been built for other service. To adopt the use of internal-combustion-engine drive on steam railroads for their light-service traffic and possibly for some of their heavier traffic successfully, it is necessary that we work along the lines of radical change or radically new development. I feel also that the necessary preliminary steps have now been taken to make these radical developments, and that soon we may look for a tremendous increase of the internal-combustion-engine drive on our railroads.

Requisites of Rail-Car Development

The three prime requisites to the development of such equipment are (*a*) economical production, (*b*) economical operation and (*c*) a high quality of service rendered. These are necessary to assure fair profits to the builder and to the railroad company and good service to the patron.

First coming to the mind of the truly interested investigator will be the question of fuel supply. The investigator will say: "Provided the equipment has been developed and will operate to the satisfaction of all concerned, what are we to do for fuel when our steam locomotives for light-service railroad-traffic are all replaced with internal-combustion-engine-drive equipment, especially when considering the steadily increasing use of the internal-combustion-engine drive for other services? Will not the increasing demand for such fuel cause the price to become prohibitive?" At first thought, the question is more or less alarming. However, within the last few years scientists, manufacturers and engineers have developed the fact that should the motor fuel now called gasoline go much above 20 cents per gal. in price, and remain more or less constant, a motor fuel equally as good if not better will be produced from vegetable growth, especially in the great Middle-West, and which will be of much benefit to the farmer, as well as to the general public. Such a motor fuel can be produced and marketed at a good profit at a price of approximately 20 cents per gal. Likewise, a heavier fuel for Diesel engines can be produced at a price not in excess of the price now in effect.

When not fearing fuel shortage or an excessive price of fuel, we can study the development of the internal-combustion-engine drive and its transmission thoroughly, with a fair chance of successfully solving the problem of design, construction and use.

Railroad management is entirely cognizant of and familiar with the fact that the steam locomotive has many shortcomings as regards economy and service when handling our railroad light branch-line traffic and, in some cases, when handling some of the light main-line traffic. The matters of crew wages, terminal handling and fuel and water supply are very pertinent, especially on branch lines. The inflexibility of the steam locomotive as regards its ability to meet the requirements of our modern light-service traffic is alone sufficient to cause its retirement and replacement if a desirable form of motive power for such service can be found. The study of any particular section of traffic to determine this fact necessitates making a study of that particular section of track or line to ascertain the possible traffic that can be secured from it, the service necessary to be rendered to secure such traffic and the kind of equipment necessary to furnish this service economically and satisfactorily. A tabulation of the present method or system and its cost and the service rendered must then be compared to similar tabulations for a more suitable equipment, provided such equipment can be found, thus reducing the matter to the very substantial basis of dollars and cents. It is not within the scope of this paper to go into any typical or actual detailed tabulation, since this is an accounting matter. The ultimate design of internal-combustion-engine equipment to meet the require-

ments of the service is, however, one that has not yet been established and is therefore, together with its operation, a most important component part of the subject.

Internal-Combustion-Engine Rail-Equipment

In arriving at the nature of the design in general, it is necessary to consider economic production first. In view of the necessity for flexibility, when it is called to mind that the equipment must serve satisfactorily all varieties of runs on short-line railroads, all kinds of branch lines and some service on main lines and at the same time be able to use not more than two different power units with possible variations of control equipment to make economic production possible, we must of necessity make a very important decision before beginning our development work. It would seem that the choosing of these two units, such as will serve all requirements, is of the greatest importance to the manufacturer or the producer, to the railroads and to the railroads' customers. Since the customers are not able to join in the development of the equipment, it is left for the manufacturers and the railroads to carry on such development, and it seems that it will be necessary for the manufacturers and the railroads to cooperate in this development so that ultimate success can be attained. Therefore, I have divided the proposed classification into two units, each of these forming a basis for multiple design and multiple operation.

Multiple Design and Operation

The first unit should be of approximately 60-hp. capacity, using gasoline as fuel. The second unit should be of approximately 300-hp. capacity, using a fuel now known as Diesel-engine fuel.

The rail-transportation service that is generally classified as light service is again subdivided into the "heavier light-service" and the "lighter light-service." Now comes the question, How can these units be utilized best for the good of all concerned? It would seem that the 60-hp. unit can be used best. It has been found that certain cylinder sizes, together with certain speeds and certain types of clutch and transmission, are produced and are operated most economically, at the same time affording satisfactory high-grade service. This is especially true when used in what is known as "hard service." M. L. McGrew has brought this point to the fore in his paper, printed herewith.

My experience regarding the use of internal-combustion engines and transmissions in rail service all tends to prove the following facts. The internal-combustion-engine clutch and transmission of the 60-hp. size has been developed to a highly satisfactory degree for the heaviest and hardest truck service. With intelligent mounting of this 60-hp. unit on a railroad car or on a light locomotive-truck, together with a suitable and satisfactory multiple-unit control, this offers to my mind the successful solution of our problem for all except the heavier class of service.

Among the advantages of the multiple system, a term used for want of a better name, the engine and the transmission used in such a system can be produced very economically in large quantities, not only for rail but for other services. When applied to a railroad truck, with a slight differentiation in gears, from one to four units or engines, complete, can be used per car or per light locomotive. One or more cars or light locomotives per train, scattered over an entire railroad system wherever required, can be utilized. Coupled with the ability to control the train from either end is the fact that each power-unit equipment is an exact duplicate of every other such equipment and thus it is easy to instruct the operators and the maintenance men. Also, the flexibility of the entire equipment enables it to meet any demands of the lighter light-service traffic that may be made upon it. These advantages make it seem that we are on the right track.

Many will say that this is entirely too radical a change, but I affirm that the extreme flexibility of the power-truck electro-pneumatic control multiple-unit system is a necessity for the lighter part of what we call our classified light-service. This flexibility is required not only from a transportation-service standpoint but likewise for economy of production and economy of maintenance and operation. No doubt many will say also that there are too many obstacles in the way of perfecting this method or system of motorization; but history has proved that, whenever the general plan or idea is right, the minor defects and the details of design and application are surmounted rapidly to the end that the goal of successful operation shall be achieved comparatively soon.

The 300-Hp. Unit

It would seem that the second unit, the 300-hp. size, can be used best for the heavier part of the service classified as light-service. The line of demarcation between the unit having approximately 60 hp. and the unit having approximately 300 hp. cannot be drawn clearly. In general, the 60-hp. unit as used on the power truck of the electro-pneumatic multiple-control rail-car is best adaptable to comparatively light trains or loads and short hauls.

The 300-hp. unit is best adapted to heavier trains or loads and longer hauls; it differs radically from the 60-hp. unit. The 300-hp. unit would consist essentially of the latest type of four-cycle multiple-cylinder Diesel-engine having efficiently designed pistons and cylinders. It would have a speed not to exceed approximately 650 r.p.m., with a system of fuel injection and distribution that eliminates the necessity for high-pressure-air piping, spray air-bottles and the like. All such equipment is very delicate and should not be used in connection with this unit. In other words, it is possible to design an oil engine having high efficiency, a light weight of approximately 60 lb. per hp. and of a ruggedness that lends itself to very reliable service, low maintenance-cost and easy operation. This unit would be designed for a constant speed and would depend upon an electric transmission consisting of a generator and a motor for the variable torque and speed requirements of the locomotive. Thus, by using an engine of this type with an electric generator, motors on the truck and the proper system of control, it is possible to build locomotives for freight, passenger or switching service on a multiple-unit basis which would have a power capacity of 300 to approximately 3000 hp.

Such equipment as this is designed primarily for heavier service than that required of the 60-hp. unit. Also, the 60-hp. unit is complete in itself when applied to a truck under a car or to a light locomotive, except for the control. To secure additional power, more engines are installed, either one additional engine to the same truck or to other trucks, and multiple or synchronous control is used with one or more complete power-units under one or more locomotives or cars, which vehicles should be of strong but light construction. But the 300-hp. unit is primarily for locomotive use. Flexibility as regards the power capacity of the locomotive is secured best by using any desired number of generators.

and motors, in multiple, in one or more locomotives. Such a unit, or such units, where more than one is required, would be installed on the underframe of the locomotive body, each engine being connected to its own generator and the electric generators being connected to bus bars.

Suppose, for example, it were desired to use a 1200-hp. locomotive for certain service. It would then be necessary to install four 300-hp. units in one locomotive, or two units in each of two locomotives, which could be operated together under multiple-unit control for one heavy train and separated for two light trains. As a matter of fact, either the 60-hp. or the 300-hp. multiple-unit system lends itself to extreme flexibility of operation for switching, freight or passenger, branch-line or main-line service as the case may be; in addition, the 300-hp. multiple-unit may be used eventually for fairly heavy main-line service.

It is well to remember that the 60-hp. multiple-unit is based on having a power unit located on a truck, mechanical transmission and an electro-pneumatic multiple-control unit-system; and that the 300-hp. unit is located in the locomotive body or cab, being mounted on the underframe, uses electric transmission and provides for electric multiple-unit control and operation of the generator and the motor or motors. In both cases, it is evident that the advantages of the multiple-unit permit extreme economy in manufacture and in operation, with all the advantages of extreme flexibility and the furnishing of a very flexible service to the patrons. The use of either of these multiple-unit systems assures a maximum of dependability and flexibility; at the same time, it is possible to distribute the weight on the driving wheels over a long power wheelbase. Light track-construction is therefore entirely satisfactory for the light branch-lines, because the heavily loaded freight cars that need to be run over such lines can be hauled carefully at slow speeds and the passenger equipments that operate at higher speeds and have light wheel-loads will not produce a bad effect on such light track.

The companies that develop such equipments on a multiple-unit basis, whether of the light or of the heavy class, should be encouraged by the railroads so that enough of these equipments will be built and operated to develop any weakness in design, with a view toward correcting faults. It is only in this way that these two classes of power for railroad motorization can be developed quickly, economically and satisfactorily.

MAY COUNCIL MEETING

THE meeting of the Council held in Detroit on May 22 was attended by President Crane, Vice-Presidents Strickland, Patitz and Ware, and Councilors Hunt, Scaife, Chryst and Rumney. The financial statement as of April 30, 1924, showed a net balance of assets over liabilities of $152,343.15, this being $30,914.54 more than the corresponding figure on the same day of 1923. The net revenue of the Society for the first 7 months of the current fiscal year amounted to $134,379.49. The operating expense during the same period was $122,547.59.

One hundred and nine applications for individual membership were approved. The following transfers in grade of membership were made: From *Junior to Associate*: Ralph B. Burton, George F. Doriot, Benjamin M. Engesser, M. D. McMaster, C. T. Olson, Wynn F. Rossiter, Frederick C. Young, Ralph R. Clark, T. T. Atangan, Edwin O. Bennett, F. Leslie Ford, Leo W. Goossen, Carl W. Horack, Earl E. Howe, Frederick A. Hoyt, Richard Kent, H. W. Langbien, Lester Morand, Edward A. Oehler, Robert B. Porter, A. H. Rowan, Herbert S. Saltzman, John M. Steinau, S. Lynn Widrig, Ernest H. Wehrli and M. R. Woodrow; *Junior to Member*: Forest S. Baster, Charles E. Heywood, F. A. Keihn, Floyd F. Kishline, S. H. Kuenzel, Mead F. Moore, William J. Outcalt, W. D. Reese, Clarence C. Stevens, William S. Stockton, Joshua Ward, Vincent C. Young and Maurice P. Whitney; *Junior to Service Member*: Charles D. King; *Associate to Member*: Alex P. Perlov.

It was reported that from Jan. 1 to May 12, 1924, 312 applications for membership, including student enrollment, had been received, as compared with 370 applications received in the same months of 1923.

The following subjects were assigned to Divisions of the Standards Committee:

Motor Vehicle Gas Head-Lamp Specifications—Lighting Division

Tap Drill Reference Tables—Screw Threads Division

W. J. Outcalt and P. W. Abbott were appointed to serve on the Sectional Committee on Plain Limit-Gages.

Frederic Nicholas was appointed to serve on the Sectional Committee on Ball Bearings.

The naming of C. G. Peterson as a representative of the National Aeronautic Association on the Sectional Committee on Aeronautical Safety Code, and of R. W. Schroeder, of the Underwriters' Laboratories, as a member of the Subcommittee on Airdromes, Traffic Rules, etc., was reported.

F. J. Bickelhaupt and W. C. Fischer were named as representatives of the Society on the Hardwood Consulting Committee.

The next meeting of the Council will be held at Spring Lake, N. J., on Tuesday, June 24.

HUMAN NATURE

THROUGHOUT all our dealings covering more than half a century we have kept in mind that human nature is the one thing in this world which never changes. Temperaments may vary, and views; but human nature is the same today as when Washington was a boy. Therefore we have tried to keep close to the human side of business and to tie our policies up with it. No dissatisfaction in any business deal can be felt so long as both parties concerned see in it an equal share of its benefits. "Sell utility, not goods!" we have told our salesmen.

The same holds true for policies. By showing our customers that our policies profit them commensurately with ourselves and by sticking to those policies, we have kept our customers' confidence. Recognition and understanding of the customer, of his human side above all, is the rock upon which we have built. And after all, understanding of the customer is nothing more than understanding of self; for the aims of manufacturer, wholesaler, retailer and consumer are fundamentally identical; each seeks profit from a transaction.—H. E. Asbury in *Forbes*.

Applicants *for* Membership

The applications for membership received between April 15 and May 15, 1924, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

ADAMS, CHARLES W., manufacturing engineer, United States Graphite Co., *Saginaw, Mich.*

AMES, AUBREY P., lubrication engineer, Standard Oil Co. of N. Y., *Manila, P. I.*

ATTENDU, ANDRE CLAUDE, president and chief engineer, Eastern Engineering Co., Ltd., *Montreal, Canada.*

BARISH, THOMAS, mechanical engineer, S. K. F. Industries, Inc., *New York City.*

BAXTER, HENRY N., mechanical engineer, Ward Motor Vehicle Co., *Mount Vernon, N. Y.*

BERTRAM, WALTER W., district office manager, Morse Chain Co., *New York City.*

BILLINGS, WILLIAM ARTHUR, automotive engineer, Associated Oil Co., *Los Angeles, Cal.*

BLAKE, H. C., manager, Foos Gas Engine Co., *Springfield, Ohio.*

BOTTA, LIEUT. RICO, bureau of aeronautics, Navy Department, *City of Washington.*

BOURNONVILLE, EUGENE, president, Bournonville Rotary Valve Motor Co., *Jersey City, N. J.*

BOWMAN, EARL RAYMOND, student, Tri-State College, *Angola, Ind.*

BRACKETT, M. E., vice-president and general manager, Clydesdale Motor Truck Co., *Clyde, Ohio.*

BRISTER, WILLIAM B., transportation engineer, White Co., *Long Island City, N. Y.*

BROOKS, DONALD B., assistant engineer, automotive power plant section, Bureau of Standards, *City of Washington.*

BUCKMAN, HERBERT, manager, Cleveland Automobile Co., *Cleveland.*

CASEY, T. A., service manager, Mack-International Motor Truck Co., *Philadelphia.*

CHATFIELD, CHARLES HUGH, assistant airplane engineer, Wright Aeronautical Corporation, *Paterson, N. J.*

COWELL, ROBERT F., assistant chief engineer, Rubber Shock Insulator Co., Inc., *New York City.*

DAVOCK, H. N., technical service manager, Packard Motor Car Co., *Detroit.*

DAWSON, H. D., research engineer, Gray & Davis, Inc., *Cambridge, Mass.*

DIETRICH, THEODORE, owner, St. Agatha Garage, *St. Agatha, Ont., Canada.*

DOW, GEORGE, H., service manager, Federal Motor Truck Co., *Detroit.*

DRUMM, CHARLES F., JR., engineer assistant to chief draftsman, International Motor Co., *New York City.*

DUMONT, R. DUVAL, vice-president and treasurer, Fink-Dumont-White, Inc., *New York City.*

DUNLAP, JAMES E., service manager, Walker Vehicle Co., *Chicago.*

DU PONT, PIERRE SAMUEL, chairman of board, E. I. du Pont de Nemours & Co., *Wilmington, Del.*, and chairman of board, General Motors Corporation, *New York City.*

EMOND, WILLIAM H., body engineer, H. H. Franklin Mfg. Co., *Syracuse, N. Y.*

ENGLAND, ALEXANDER, chief engineer, Westinghouse Air Brake Co., *Wilmerding, Pa.*

FOKKER, A. H. G., airplane constructor, Director of N. V. Nederlandsche Bliegtuigenfabriek, *Amsterdam, Holland.*

FRANCIS, DEAN D., assistant superintendent Marvel Carburetor Co., *Flint, Mich.*

FRANK, GERHARDT, W., airplane engine inspector, Curtis Aeroplane & Motor Corporation, *Buffalo, N. Y.*

FRANKLAND, EDWIN, master mechanic, General Motors Truck Co., *Pontiac, Mich.*

FRINS, MAXIMILIAN C., chief draftsman, International Motor Co., *New York City.*

FURST, ROBERT S., rate setter, Sheldon Axle & Spring Co., *Wilkes Barre, Pa.*

GFROERER, HERBERT, Cadillac Motor Car Co., *Detroit.*

GOLDSMITH, JOHN, designer, International Motor Co., *New York City.*

GURNEY, GEORGE C., director of service, Columbia Motors Co., *Detroit*

HABERMAS, W. J., mechanical department, B. F. Goodrich Rubber Co., *Detroit.*

HALLIBURTON, VIRGIL E., student, Massachusetts Institute of Technology, *Cambridge, Mass.*

HALLOCK, EDWARD F., manager of manufacturers' service division, Vacuum Oil Co., *New York City.*

HARKNESS, THOMAS H., service engineer Rolls-Royce of America, Inc., *Springfield, Mass.*

HAZEN, H. M., instructor in mechanical engineering, University of Minnesota, *Minneapolis.*

HINSHAW, RUE, co-partner, Carmel Garage, *Carmel, Ind.*

HOAG, CHAUNCEY A., engineer of tests, Hayes Wheel Co., *Jackson, Mich.*

HOPKINS, R. Z., plant superintendent, Hudson Motor Car Co., *Detroit.*

HOSLEY, L. F., manager and chief engineer, du Pont Motors, *Moore, Pa.*

HOWARD, KENNETH, assistant sales manager, U. S. Axle Co., *Pottstown, Pa.*

HOWARD, WILLIAM L., treasurer, Jackson Electric Co., *Boston.*

HUNDERUP, LEO F., salesman, Walden-Worcester, Inc., *Worcester, Mass.*

JABAS, W. G., superintendent of motor transport, Treasury Department, *City of Washington.*

JAY, HAROLD, sales engineer, Acklin Stamping Co *Toledo, Ohio.*

JONSSON, SWEN M., engineer, International Motor Co., *New York City.*

KELLY, JOSEPH W., mechanical illustrator, International Motor Co., *New York City.*

KEMPER, CARLTON, Packard Motor Car Co., *Detroit.*

KESSING, ALBERT F., secretary and treasurer, Porterville Machine Works, *Porterville, Cal.*

KIGHT, LINWOOD, general manager, Norfolk Machine Works, Inc., *Norfolk, Va.*

KOHLBERGER, FRANK, draftsman and engineer, International Motor Co., *New York City.*

LANG, JOHN FREDERICK, designing draftsman, J. G. Brill Co., *Philadelphia.*

LANG, RICHARD, technical director and factory manager, Daimler Motoren Gesellschaft, *Stuttgart Unterturkheim, Germany.*

LIEDABRAND, S. E., chief engineer, Automotive Trailer Corporation, *Springfield, Ill.*

LIPCOT, F. L., chemical engineer, Rubber Shock Insulator Co., Inc., *New York City.*

LOWELL, J. OLIVER, service manager, Vesper Buick Auto Co., *St. Louis.*

MCCLURE, MAJOR CHARLES W., Quartermaster Corps, *Governors Island, N. Y.*

MCCUNE, EDWARD B., designing engineer, Nelsen LeMoon Motor Truck Co., *Chicago.*

MCLEAN, LANE, vice-president and general manager, Brooks Steam Motors, Ltd., *Stratford, Ont., Canada.*

MCMULLIN, RAY D., layout draftsman, Nash Motors Co., *Milwaukee.*

MCPROUD, C. GILBERT, engineering student, California Institute of Technology, *Pasadena, Cal.*

MACAULEY, JOHN B., JR., experimental department, Chrysler Motor Corporation, *Detroit.*

MAY, WALTER O., production manager, Automotive Trailer Corporation, *Springfield, Ill.*

MEACHEM, T. G., president, Meachem Gear Corporation, *Syracuse, N. Y.*

MIDBOE, G., designer, International Motor Co., *New York City.*

MILES, BURTIS D., service complaint engineer, International Motor Co., *New York City.*

MURCH, STANLEY, student, Tri-State College, *Angola, Ind.*

OGILVIE, VICTOR J., mechanical superintendent, Massachusetts Automobile Club, *Boston.*

PARK, CHARLES F., professor of mechanism, Massachusetts Institute of Technology, *Cambridge, Mass.*

PARSONS, C. MAYNARD, Franklin Automobile Co., *Syracuse, N. Y.*

PAXTON, SAMUEL M., president S. M. Paxton Co., *Cleveland.*

PETTIT, HAYES D., shop superintendent Pennsylvania Department of Highway, *Harrisburg, Pa.*

PEW, ARTHUR E., JR., charge of control department, Sun Oil Co., *Philadelphia.*

PIKE, JAY R., student, University of Minnesota, *Minneapolis.*

PLATZ, HENRY A., safety engineer, Michigan Employers' Casualty Co., *Lansing, Mich.*

POTTS, WILLIAM, chief driving instructor, Detroit Motor Bus Co., *Detroit.*

RAHN, ERNEST H., service engineer, U. S. Ball Bearing Mfg. Co., *Chicago.*

RAMSDELL, SAYRE M., advertising manager, Philadelphia Storage Battery Co., *Philadelphia.*

REMSEN, ALFRED H., service manager, Rickenbacker Motor Co., *Detroit.*

ROBBINS, AZOR D., assistant engineer, International Motor Co., *New York City.*

RODGERS, WALTER I., engineer, International Motor Co., *New York City.*

ROWLING, HOMER J., electrical instructor, Ambu Engineering Institute, *Chicago.*

RUMP, OTTO H., chief draftsman, Ross Gear & Tool Co., *Lafayette, Ind.*

ST. HORNOW, JOHN, superintendent of automobile equipment, Arbuckle Bros., *Brooklyn, N. Y.*

SAWDERS, F. P., JR., purchasing agent and chief engineer and general manager, Pittsburgh Truck Mfg. Co., *Pittsburgh.*

SCHWEIZER, PAUL EUGENE, mechanical engineer, Westinghouse Electric & Mfg. Co., *New York City.*

SCRAGG, GEORGE H., executive, International Motor Co., *New York City.*

SEDELL, ALBERT E., superintendent, Beneke & Kropf Mfg. Co., *Chicago.*

SHANK, JOHN A., service manager, Electric Auto-Lite Co., *Toledo.*

SPONDER, HARRY K., chief draftsman, Lang Body Co., *Cleveland.*

STETLER, CHARLES ERNEST, production manager, Light Mfg. Co., *Pottstown, Pa.*

STORRS, LUCIUS S., railway executive, Connecticut Co., *New Haven, Conn.*

STURGES, EDWARD BAKER, sales manager, Weiss Engineering Association, *New York City.*

SULLIVAN, HERBERT I., superintendent of power and automotive equipment Eastern Massachusetts Street Railway Co., *Boston.*

SWIFT, SHERMAN G., editor, Automobile Journal Publishing Co., *Pawtucket, R. I.*

TEETER, MACY ORVILLE, assistant sales manager, Indiana Piston Ring Co., *Hagerstown, Ind.*

TOLLZIEN, C. F., sales representative, General Motors Building, *Detroit.*

TRUMBOWER, DON M., service and repairs, Don M. Trumbower, *Forest Hills, N. Y.*

WALLACE, JOHN RAY, factory representative, Millard & Co., Inc., *San Francisco.*

WARNER, O. W., service manager, Roamer Motor Car Co., *Kalamazoo, Mich.*

WEINBERG, SAMUEL, sales and merchandise manager, H. Weinberg & Son, *Brooklyn, N. Y.*

WILBER, CARL L., manager, forge division, Timken-Detroit Axle Co., *Detroit.*

WOOD, EDWIN T., metallurgical engineer, Wheeling Steel Corporation, *Steubenville, Ohio.*

Applicants *Qualified*

The following applicants have qualified for admission to the Society between April 10 and May 10, 1924. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member; (E S) Enrolled Student.

ANDERSON, M. C. (J) engineer, Lee Trailer & Body Co., *Chicago,* (mail) Metropole Hotel, 2300 South Michigan Avenue.

BEST, HERBERT W. (J) care Mrs. W. Best-Anderson, Bellaria, La Tour de Peilz, *Vevey, Switzerland.*

BROWN, H. FLETCHER (E S) student, Iowa State College, Ames, Iowa, (mail) 3522 West 4th Street, *Des Moines, Iowa.*

COOPER, HOWARD (M) assistant supervising engineer of lubrication department, Sinclair Refining Co., 45 Nassau Street, *New York City.*

EDGARTON, LEWIS S. (J) instructor, Mechanics Institute, *Rochester, N. Y.*

FERGUSON, GUY M. (A) assisting the material specification inspection engineer, American Locomotive Co., Schenectady, N. Y., (mail) 242 Lark Street, *Albany, N. Y.*

FUKUI, SHIRO (F M) 84 Yakojicho Ushikomeku, *Tokyo, Japan.*

HALLIGAN, WILLIAM C. (J) draftsman, Yellow Sleeve Valve Engine Works, East Moline, Ill., (mail) 905 Farnam Street, *Davenport, Iowa.*

HARTMAN, EUGENE L. (A) engineer, Hartman Supply Co., Inc., Pittston, Pa., (mail) 201 Luzerne Avenue, *West Pittston, Pa.*

HEENEY, TERRENCE J. C. (A) assistant cable engineer, Northern Electric Co., Ltd., 121 Shearer Street, *Montreal, Que., Canada,* (mail) 804-B Dorchester Street, West.

KLINKICHT, CHARLES F. (A) chief electrician and carbureter and battery trouble man, Jost Storage Battery Co., Jamaica, N Y., (mail) 9319 112th Street, *Richmond Hill, N. Y.*

LAWLESS, WALTER (A) mechanical superintendent, Doyle Motors Ltd., *Toronto, Ont., Canada,* (mail) 92 Monarch Park Avenue.

LECESTRE, H. C. (M) body engineer, Brooks Steam Motors, Ltd., Stratford, Ont., Canada, (mail) 651 East Drive, Woodruff Place, *Indianapolis.*

MORITZ, JULIUS H. (J) 523 East Vine Street, *Lima, Ohio.*

NICHOLSON, EARLE J. (J) draftsman, H. H. Franklin Mfg. Co., *Syracuse, N. Y.,* (mail) 1407 North First Street.

NIPPS, L. H. (E S) student, Kansas State Agricultural College, *Manhattan, Kan.,* (mail) 123 Vattier Street.

PARRILL, FRANK L. (A) sales promotion manager, Prest-O-Lite Co., Inc., *Indianapolis,* (mail) 219 East Fall Creek Boulevard.

PAYTON, EDWARD (A) president and sales manager, Used Car Bureau of Cleveland Co., Room 313, 5005 Euclid Avenue, *Cleveland.*

SAGE, FRED L. (M) chief engineer, Mason Motor Truck Co., *Flint, Mich.,* (mail) 2917 Fenton Road.

SIMPSON, THERON B. (J) manufacturing engineering department, Olds Motor Works, *Lansing, Mich.,* (mail) 1337 Knollwood Avenue.

TYLER, RALPH H. (A) general superintendent, Herbrand Co., *Fremont, Ohio.*

VERNET, SERGIUS (J) chief engineer, Motorcraft Engine Corporation, New York City, (mail) 54 Linden Avenue, *Brooklyn, N. Y.*

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Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

At the district convention of the National Aeronautic Association held recently in Boston, **Porter H. Adams** was reelected one of the vice-presidents of the association. Mr. Adams is one of the original incorporators of the association and during the past year has served as its representative on the Aeronautic Division of the Standards Committee of the Society.

William A. Baker has been appointed sales manager of the Firestone Steel Products Co., and will be located in its general offices in Akron, Ohio. He was previously manufacturers' representative in the Detroit office of the company.

C. H. Barton, who was formerly designing engineer for Weidely Motors Co., Indianapolis, has accepted a similar position with the Insley Mfg. Co., also of Indianapolis.

Roy E. Berg has joined the sales department of the United Mfg. & Distributing Co., Chicago. Until recently he was vice-president and general manager of the Columbia Carbureter Co., also of Chicago.

Robert H. Campbell, who formerly was purchasing agent for the William R. Johnston Mfg. Co., Chicago, is now engaged in business for himself with offices in the Monadnock Building of that city.

DeWitt Clausen has accepted a position as designer for the A. O. Smith Corporation, Milwaukee. Prior to this he was assistant engineer in the steam department of the Climax Engineering Co., Clinton, Iowa.

T. F. Cullen was appointed news editor of the Chilton publications on Dec. 1. For the past 5 years Mr. Cullen has been managing editor of the *Automobile Trade Journal.* In his new position he will devote his time to maintaining contact with the leading executives of the automobile industry and studying conditions at the factories and will make his headquarters at the Detroit office of the Chilton Co., 1408 Kresge Building.

Charles H. Day, who was formerly chief engineer for the Aerial Transport Corporation, New York City, and also associated with the Rogers Construction Co., Gloucester City, N. J., has become sales engineer for the Elektron Metals Corporation of America, New York City.

Edgar N. Dollin is engaged in business for himself with office at 6 Church Street, New York City. His previous business connection was with the Precision Castings Co., Syracuse, N. Y., as general manager.

Ralph P. Domjam has been made service manager for Murphy & Diamond, Inc., New York City. Until recently he was service representative of the New York Yellow Cab Co., also of New York City.

W. E. Duersten has been appointed general manager and chief engineer of the Wireless Resistor Co. of America, Milwaukee.

R. L. Eastman has accepted a position as draftsman for the American Rolling Mill Co., Ashland, Ky. He was formerly staff engineer for the Aultman & Taylor Machinery Co., Mansfield, Ohio.

(*Continued on p.* 4)

Stewart

Keeping Pace With Demand

Big Success of

Perfect Bearing Metal

Requires New Production Unit

The first announcement of the perfect bearing metal was made to the trade in October, 1922. This bearing metal was christened Stewart Brons.

Today, only one year after this announcement, a new foundry, modern in every detail of building and equipment, is in full operation, made necessary by the constantly increasing demand for Stewart Brons Bearing Metal.

The revolutionary improvement in bearing metal wrought by the solution of a problem which had baffled chemists for centuries was accorded immediate recognition by bearing metal users everywhere.

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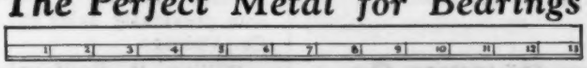
J. FRANK LANNING & CO., 327 First Avenue, Pittsburgh, Pa.
E. P. GRISMER, 1982 E. 66th Street, Cleveland, Ohio
UNGAR & WATSON, 1366 S. Figueroa St., Los Angeles, Calif.
L. NELSON, 820 N. Meridian St., Indianapolis, Ind.

Stewart Brons Bearing Metal

Stewart

The Perfect Metal for Bearings

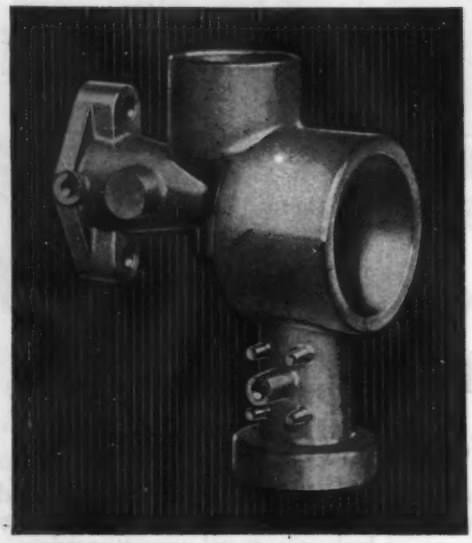


13" BAR
SAVES 50% OF YOUR BEARING METAL

DOEHLER

The World's Largest Producer of

DIE-CASTINGS



Occasionally, a change from machined to die-cast parts would involve preliminary experiment and expense which a logical user of die-castings may hesitate to enter upon.

Doehler engineers are always ready to work with such a prospective customer—to make with him, in his own plant, a survey of his product and processes—to study his individual problem in detail—and to make recommendations based upon an unequaled experience.

And the Doehler Company will share with the prospective buyer the expense involved in this survey and development.

DOEHLER DIE-CASTING CO.
BROOKLYN. N.Y.
TOLEDO. OHIO.

PERSONAL NOTES OF THE MEMBERS

Continued

Henry Factor is no longer production manager for the Lawrance Aero Engine Co., New York City, but is engaged in production work for the Wright Aeronautical Corporation, Paterson, N. J.

David Fergusson has become affiliated with James Cunningham, Son & Co., Rochester, N. Y., as chief engineer. Early in the year he severed his connection with the Pierce-Arrow Motor Car Co., Buffalo, and since then has maintained an office as consulting engineer in that city.

H. T. Hanover, who was formerly president and general manager of the Apex Motor Co., Ypsilanti, Mich., has become associated with the Westcott Motor Car Co., Springfield, Ohio.

J. Harrison has been appointed service manager for the Anthony Motors, Inc., Minneapolis. Previous to this he was connected with the service department of the Packard Motor Car Co., Chicago.

John A. Heckman has accepted a position as draftsman and is doing designing in connection with tools, fixtures and jigs for the Landis Machine Co., St. Louis. He was until recently production engineer for the Heckman Signal Co., also of St. Louis.

Van Wyck Hewlett, who was designer for the Hendee Mfg. Co., Springfield, Mass., now holds a similar position with the Indian Motorcycle Co., which is the new name of the Hendee organization.

Herman Hollerith, Jr., has become associated with the Victor Talking Machine Co., Camden, N. J. He was previously secretary and engineer for the John Harrison, Jr., Co., Inc., Holmesburg, Philadelphia.

J. Charles Hooper has severed his connection with the Miho Co., Cincinnati, where he was secretary and treasurer. No announcement has been made of his future plans.

G. F. Jontz, who was formerly supervisor of engine building at the tractor works of the Moline Plow Co., Rock Island, Ill., is now associated with the Climax Engineering Co., Clinton, Iowa.

E. B. Libbey has accepted a position as salesman for the Peerless Motor Car Co., New York City. His previous business connection was with the Cole Motor Car Co., also of New York City, in the sales department.

W. M. Mansfield has charge of sales and service of Paige and Jewett cars for the Mansfield Motor Co., South Pasadena, Cal. Prior to this he was tractor engineer in the tractor works of the Moline Plow Co., Rock Island, Ill.

Harold M. Martin is now associated with the General Electric Co., and will be in charge of electric dynamometer sales and engineering at the Bloomfield, N. J., works. He was formerly service engineer for the Bijur Motor Lighting Co., Hoboken, N. J.

F. E. Moskovics, who until recently was vice-president of the Nordyke & Marmon Co., Indianapolis, is now engaged in industrial engineering work, acting in an advisory capacity to various companies. He has also taken over the receivership of the Stevenson Gear Co., also of Indianapolis.

Frederick P. Nehrbas is no longer vice-president and a director of the Weidely Motors Co., Indianapolis, but has become affiliated with the Templar Motor Car Co., Cleveland.

Joseph E. Padgett has been appointed assistant factory manager for the Winslow Glass Co., Columbus, Ohio. He was previously sales engineer for the Beneke & Kopf Mfg. Co., Chicago.

William H. Pratt, who until recently was manager of the New York branch of the Timken Roller Bearing Service Sales Co., New York City, is now doing business under the title of the Houdaille Baltimore Service, Baltimore.

—(*Concluded on p. 6*)

BAKELITE

NEW ECONOMIES
for Manufacturers of interchangeable parts

Complicated manufacturing methods often discount the advantages of excellent design. In multiple production, simplicity is the primary source of economy.

It is in simplifying production that molded Bakelite parts have made a notable contribution to economical shop practice.

A single closing of a molding press often completes an intricate part that formerly required both machining operations and hand assembly. Direct labor costs are greatly reduced.

Any desired degree of finish may be secured in the molding die. When polished dies are used the molded part has an equally high lustre.

Metal inserts may be solidly embedded in the molding operation. Relief lettering or markings may be sharply defined.

We invite automotive engineers who have problems in multiple parts manufacture, involving the use of metal, wood, fibre, porcelain or other materials, to enlist the service of our Research Departments.

Describe your problem to us, send sample of the part as now made, and we will advise you as to the suitability of Bakelite for the purpose.

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.
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Condensite
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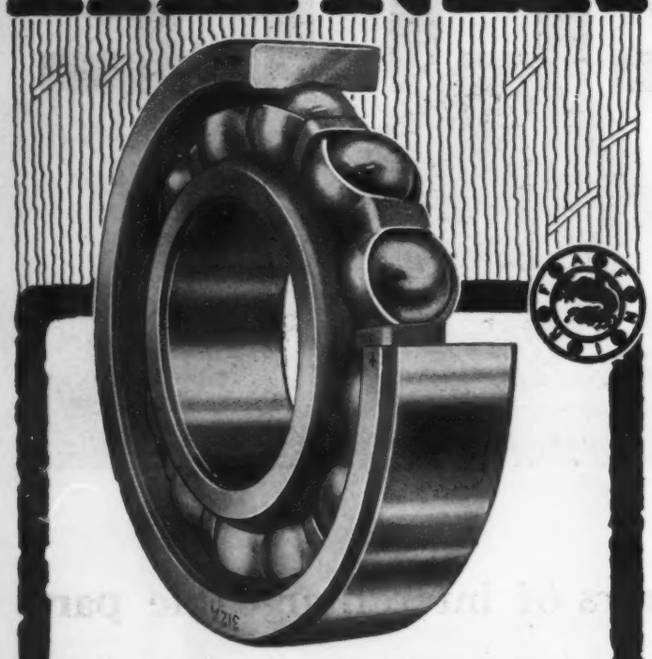
are the registered Trade Marks for the Phenol Resin Products manufactured under patents owned by
BAKELITE CORPORATION

THE MATERIAL OF A THOUSAND USES

FAFNIR



EVERYONE who realizes the vast number of revolutions made by the wheels, transmission and drive shafts for every mile of travel, gives serious consideration to the bearings when buying a car.

Fafnir Ball Bearings of all standard types and sizes are manufactured with the utmost accuracy and finish from thoroughly heat treated chrome alloy steel, virtually eliminating friction and wear.

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CLEVELAND, OHIO
1016-1017 Swetland Bldg.

PHILADELPHIA, PA.
1427 Fairmont Ave.

PERSONAL NOTES OF THE MEMBERS

Concluded

L. H. Preston has become affiliated with the American LaFrance Fire Engine Co., Elmira, N. Y. He was formerly engineering observer for the Stephens Motor Works, Freeport, Ill.

Vernon Scobie has been appointed transportation engineer for the Texas Co., New York City. Prior to this he was chief instructor in the West Side Y. M. C. A. Automobile School, also in New York City.

Thomas K. Senior is no longer assistant chief engineer for the Cleveland Automobile Co., Cleveland, but has become designing engineer for the Bourne-Fuller Co., also of Cleveland.

C. B. Stebbins has severed his connection with the Climax Engineering Co., Clinton, Iowa, of which he was vice-president and general manager. His plans for the future have not been announced.

T. J. Turk has become associated with the Indianapolis Pressed Steel Co., Indianapolis.

Gordon T. Waite has received a commission as second lieutenant in the Air Service and has been assigned to the 95th Pursuit Squadron, located at Selfridge Field, Mount Clemens, Mich. He recently took a course in mechanical aeronautical engineering at the University of Michigan, Ann Arbor, Mich.

Edwin S. Wheeler, who was formerly sales representative of the Wheeling Bronze Casting Co., Wheeling, W. Va., has become a partner in the Metal Specialties Sales Co., New York City.

FOR ANY SPRING USER

We have prepared a chart for ready reference in designing helical springs to go in a given space to support a given load.

Given any two of the following specifications, this chart will automatically solve for the other two:

Outside Diameter
Load at 60,000 lbs. fibre stress
Diameter of Wire
Deflection per coil per 100 lbs.

Gladly sent at your request.

The Wallace Barnes Co.

"Spring-makers for Three Generations"

Bristol, Connecticut

Champions!

INDIAN motorcycles which won eight of eleven national championships during 1923 were equipped with Thompson Silcrome Valves. In this field of severe service valves of Thompson Silcrome have gained practically universal adoption. Hottest engines, cooled solely by air and exposed to every atmospheric condition, do not affect them. They are standard equipment in leading motorcycles, as in finest cars, planes, trucks and tractors, because they are virtually indestructible.

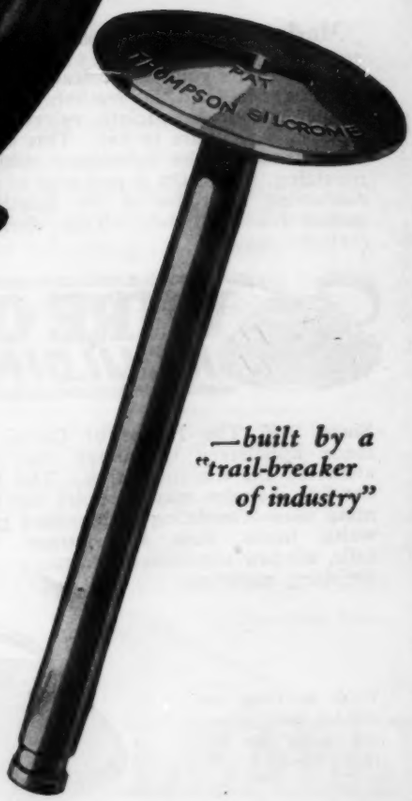
Prove their remarkable stamina in your own test engines.

THE STEEL PRODUCTS COMPANY

Also manufacturers of king bolts, shackle bolts, tie rod bolts, drag links, starting cranks, and brake rod assemblies

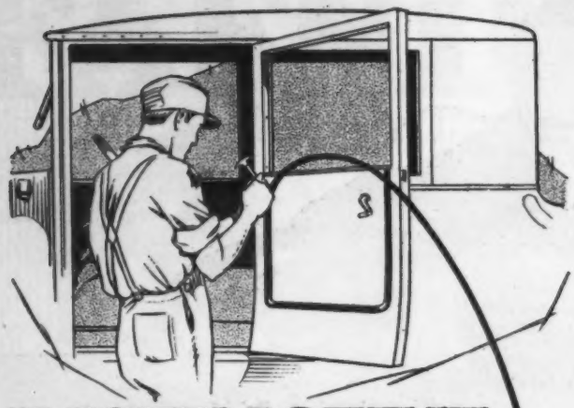
Main Plant
CLEVELAND

Michigan Plant
DETROIT



—built by a "trail-breaker of industry"

THOMPSON SILCROME VALVES



DISTINCTIVE
yet surprisingly economical

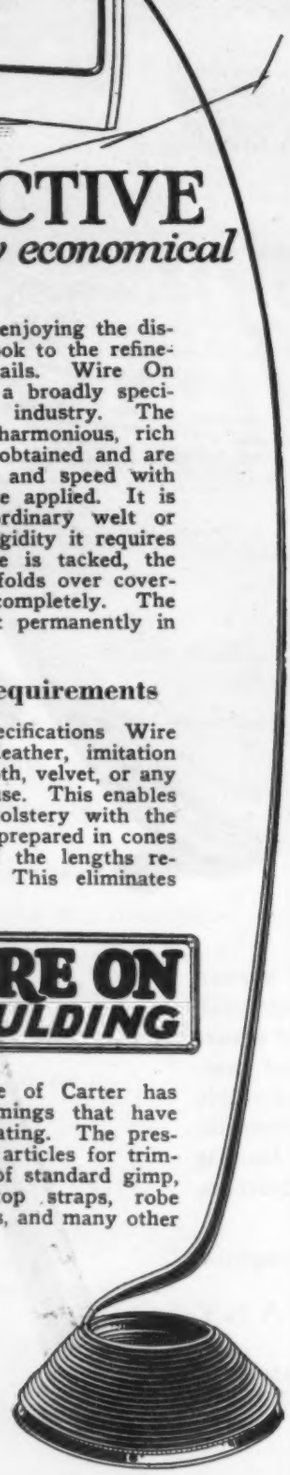
Body builders who are enjoying the distinction of leadership look to the refinement of finishing details. Wire On Moulding is becoming a broadly specified material in that industry. The trimmers know what harmonious, rich finished effects can be obtained and are familiar with the ease and speed with which Wire On can be applied. It is tacked on like any ordinary welt or gimp, yet due to its rigidity it requires fewer tacks. One side is tacked, the other, half-round side, folds over covering the tack heads completely. The wire backbone holds it permanently in shape.

Made to Your Requirements

Prepared to your specifications Wire On may be had in leather, imitation leather, velour, broadcloth, velvet, or any material you desire to use. This enables you to match the upholstery with the moulding. Wire On is prepared in cones containing multiples of the lengths required for each job. This eliminates material waste.

Since 1896 The House of Carter has made upholstery trimmings that have attracted the discriminating. The present line includes many articles for trimming uses—consisting of standard gimp, welts, boots, door stop straps, robe rails, window mouldings, and many other finishing materials.

Write us today for samples and prices. Ask about our 24-Hour Service.



The Geo. R. Carter Co.
CONNERSVILLE, INDIANA

Notes and Reviews

In this column are given brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

THE LAUNCHING OF AIRCRAFT FROM SHIPS. By L. J. Wackett. Published in the *Journal of the Royal Aeronautical Society*, November, 1923, p. 553.

In this paper, equations are derived which make it possible to find the minimum propeller thrust necessary to enable an aircraft, particularly a seaplane or flying boat, of known weight and fineness, to take-off from a railroad platform on a ship steaming at a given speed. Emphasis is laid on the pronounced advantage of a speedy ship in this connection.

ANALYSIS OF W. F. DURAND'S AND E. P. LESLEY'S PROPELLER TESTS. By Max M. Munk. National Advisory Committee for Aeronautics Report No. 175. Published by the National Advisory Committee for Aeronautics, City of Washington. 14 pp.; 21 illustrations.

This report is a critical study of the results of propeller model tests with the view of obtaining a clear insight into the mechanism of the propeller action and of examining the soundness of the physical explanation generally given. The nominal slipstream velocity is plotted against the propeller tip velocity, both measured by the velocity of flight as a unit. Within the range corresponding to conditions of flight, the curve thus obtained is a straight line. Its inclination depends chiefly on the effective blade width; its position, on the effective pitch. These two quantities can therefore be determined from the result of each propeller test. Both can easily be estimated therefrom for new propellers of similar type. Thus, a simple method for the computation of propellers suggests itself.

The slip curve mentioned is not a straight line along its entire length. At a small relative velocity it is bent up, because the lift curve of the blade sections used is bent up that way at small lift coefficients. At a certain relatively high tip velocity the slip curve shows a break and then runs straight again but at a different slope. The slope is increased so that at zero advance the propeller develops a larger thrust than could be expected from the magnitude of the thrust in flight.

RELIABLE FORMULAS FOR ESTIMATING AIRPLANE PERFORMANCE AND THE EFFECTS OF CHANGES IN WEIGHT, WING AREA OR POWER. By Walter S. Diehl. National Advisory Committee for Aeronautics Report No. 173. Published by the National Advisory Committee for Aeronautics, City of Washington. 22 pp.

This paper contains the derivation and the verification of formulas for predicting the speed-range ratio, the initial rate of climb and the absolute ceiling of an airplane.

HOW 200 BUSES ARE PUT UNDER ONE ROOF. By Martin C. Schwab. Published in *Bus Transportation*, November, 1923, p. 509.

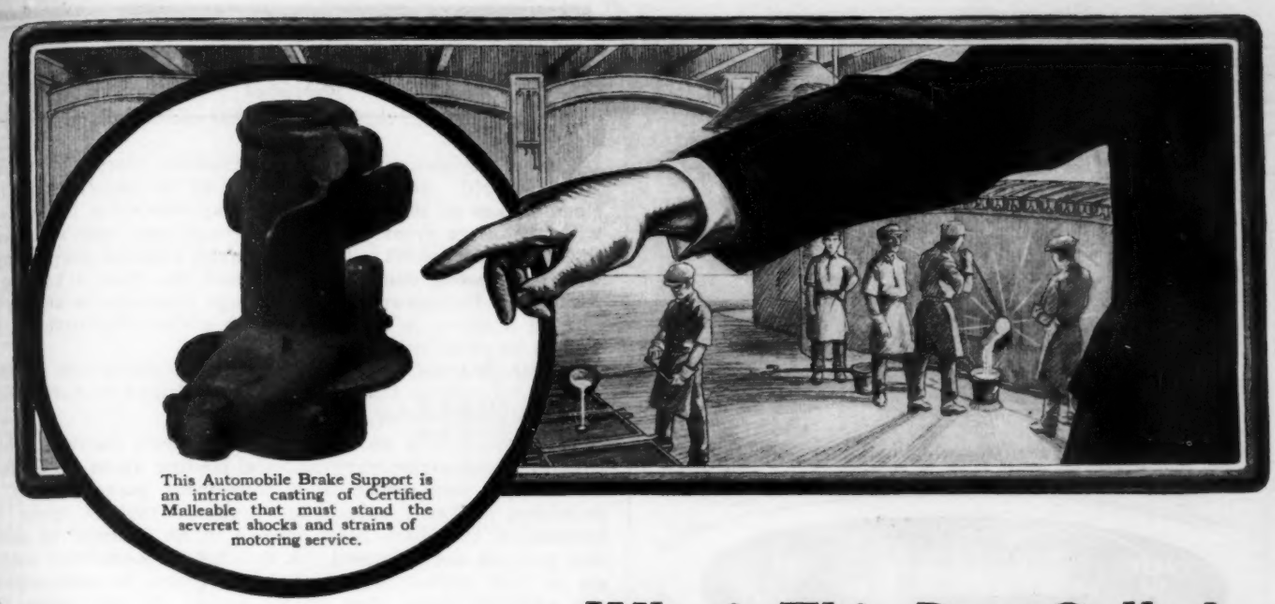
This is a description of the new garage of the Chicago Motor Coach Co., which is said to have ample capacity to handle approximately 200 buses, together with the necessary service and emergency equipment.

Features of the building that are considered in detail include the amount of free floor space, light, fuel and oil storage and distribution, heating system, ventilating system, accommodations for employes and fire protection. A floor plan is given, showing the gutters and the inspection pits, and a smaller drawing illustrates the roof construction.

SOME CONFESSIONS OF A SIX-WHEELER. Published in *Bus Transportation*, November, 1923, p. 529.

The vehicle described in this article is the Class C truck that is now being tried out experimentally by the motor

(*Continued on p.* 10)



This Automobile Brake Support is an intricate casting of Certified Malleable that must stand the severest shocks and strains of motoring service.

Why is This Part Called "Certified Malleable?"

"Certified", in the Malleable Castings business, means the same as sterling applied to silverware.

"Certified Malleable" is the product of those companies who receive quarterly certificates of merit from the Association's consulting engineer; declaring that their product for the quarter indicated met his exacting tests and plant inspections.

Buyers of castings should know that the product of every foundry must show the highest quality before the name of that company can appear on this page, as a maker of Certified Malleable Castings. Companies have striven for years to get their names on this list, even going to the expense of rebuilding their plants and revamping their equipment and foundry practice in their efforts to meet the Association's requirements for Certified Malleable Castings.

The American Malleable Castings Association has been a leader in the matter of establishing higher quality standards at which its members could aim—a principle now so strongly urged by the United States Department of Commerce. This guardianship of consumers' interests can be likened to the Trade Guild activities of the middle ages.

THE AMERICAN MALLEABLE CASTINGS ASSN.

The 1900 Euclid Building Cleveland, Ohio

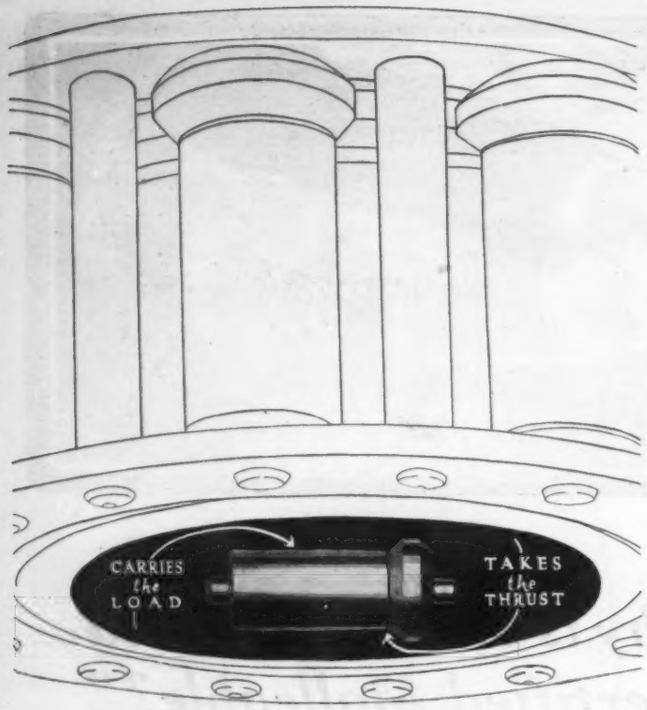
MAKERS OF CERTIFIED MALLEABLE CASTINGS

Certificate Holders for the Quarter Ending September 30th, 1923

Albany Malleable Iron Co. ..... Voorheesville, N. Y.
Albion Malleable Iron Co. ..... Albion, Mich.
Amerford Chain Co. ..... Bridgeport, Conn.
American Malleable Castings Co. ..... Marion, O.
American Malleable Co. ..... Lancaster, N. Y., and Owosso, Mich.
Badger Malleable & Mfg. Co. ..... South Milwaukee, Wis.
Baltimore Malleable Iron & Steel Casting Co. ..... Baltimore, Md.
Belle City Malleable Iron Co. ..... Racine, Wis.
Chain Belt Co. ..... Milwaukee, Wis.
Chicago Malleable Castings Co. ..... West Pullman, Chicago, Ill.
Columbia Malleable Castings Co. ..... Columbia, Pa.
Columbus Malleable Iron Co., The ..... Columbus, O.
Danville Malleable Iron Co. ..... Danville, Ill.
Dayton Malleable Iron Co. ..... Dayton, O., Ironton, O., and Canton, O.
Decatur Malleable Iron Co. ..... Decatur, Ill.
Devlin Mfg. Co., Thomas ..... Philadelphia, Pa.
Eastern Malleable Iron Co., The ..... Naugatuck Malleable Iron Works, Naugatuck, Conn.; Bridgeport Malleable Iron Works, Bridgeport, Conn.; Troy Malleable Iron Works, Troy, N. Y.; Wilmington Malleable Iron Works, Wilmington, Del.; Vulcan Iron Works, New Britain, Conn.
Erie Malleable Iron Co. ..... Erie, Pa.
Federal Malleable Co. ..... West Allis, Wis.
Fort Pitt Malleable Iron Co. ..... Pittsburgh, Pa.
Fraser & Jones Co. ..... Syracuse, N. Y.
General Electric Co. ..... Erie, Pa.
Grancy Malleable Corporation ..... Waukesha, Wis.
Illinois Malleable Iron Co. ..... Chicago, Ill.
Iowa Malleable Iron Co. ..... Fairfield, Ia.
Laconia Car Co. ..... Laconia, N. H.
Link-Belt Co. ..... Indianapolis, Ind.
Marion Malleable Iron Works ..... Marion, Ind.
Moline Malleable Iron Co. ..... St. Charles, Ill.
National Malleable Castings Co., The ..... Cleveland, O., Chicago, Ill., Indianapolis, Ind., Toledo, O., E. St. Louis, Ill.
Northern Malleable Iron Co. ..... St. Paul, Minn.
Northwestern Malleable Iron Co. ..... Milwaukee, Wis.
Pittsburgh Malleable Iron Co. ..... Pittsburgh, Pa.
Rhode Island Malleable Iron Works ..... Hillsgrove, R. I.
Rockford Malleable Iron Works ..... Rockford, Ill.
Ross-Meehan Foundries, The ..... Chattanooga, Tenn.
St. Louis Malleable Casting Co. ..... St. Louis, Mo.
Saginaw Malleable Iron Co. ..... Saginaw, Mich.
Standard Malleable Castings Co. ..... Terre Haute, Ind.
Stowell Co., The ..... South Milwaukee, Wis.
Superior Steel Castings Co. ..... Benton Harbor, Mich.
Symington Co., T. H., The ..... Rochester, N. Y.
Temple Malleable Iron & Steel Co. ..... Temple, Pa.
Terre Haute Malleable & Mfg. Co. ..... Terre Haute, Ind.
Trenton Malleable Iron Co., The ..... Trenton, N. J.
Union Malleable Iron Co., The ..... E. Moline, Ill.
Vermilion Malleable Iron Co. ..... Hoopeston, Ill.
Wagner Malleable Castings Co. ..... Hammond, Ind.
Warren Tool & Forge Co. ..... Warren, Ohio
Webster Mfg. Co., The ..... Chicago, Ill.
Wisconsin Malleable Iron Co. ..... Milwaukee, Wis.
York Mfg. Co. ..... York, Pa.
Zanesville Malleable Co. ..... Zanesville, O.

POSITIVE PHYSICAL PROPERTIES
AcA CERTIFIED TRADE MARK

CERTIFIED-MALLEABLE CASTINGS



Bower popularity is gaining every day. This without question must be due to the correct fundamental Bower designs and exclusive features.

The little slogan, "Carries the load —takes the thrust," in a very simple way explains one of the secrets of the great staying qualities of the Bower Roller Bearing.

We would like to explain further the many other superior points of this well-known bearing, which continue to interest so many of the well-known automobile manufacturers. May we?

BOWER SAVES POWER

BOWER
ROLLER BEARING CO.
Detroit · Michigan

NOTES AND REVIEWS

Continued

transport division of the Quartermaster Corps at Camp Holabird, Md. Important features of its construction include brakes on the four rear wheels; rear axles in tandem with the drive from the front through one axle and then through a short shaft to the second axle; a second gear change with two speeds, one being direct and the other a 1.63 to 1 reduction. Photographs and drawings illustrate its action in turning a curve, in stopping and in taking obstructions, as well as its effect on the highway.

VARIABLE TRANSMISSIONS, A CRITICAL CONSIDERATION OF THE PROBLEM. By G. Constantinesco. Published in *Automobile Engineer*, November, 1923, p. 322.

This article does not explain the author's converter, but contains some preliminary material leading up to an exposition of his own device in a subsequent paper. After a definition of the transmission problem, various types of mechanism that have been devised in an attempt to solve this problem are discussed. A detailed mathematical analysis of their underlying principles is given, to substantiate the author's claim that these devices do not solve the problem.

It is stated that the author's converter is not an improvement on any known change-speed gear but is the result of the application of mathematical principles to the solution of certain problems, using an entirely new method of theoretical research.

One feature of the present paper is the publication of two diagrams that were previously published, it is stated, without proper authorization. It is pointed out that these diagrams were made from authentic sketches but were simplified by others presumably to make the operation of the various parts clearer to the reader, with the result that the arrangement, the author takes pains to show, is unworkable.

CAPITALIZING ON COLOR HARMONY IN AUTOMOBILES. By Hazel H. Adler. Published in *Autobody*, December, 1923, p. 211.

This paper deals with the present demand for more striking color combinations in automobile painting, discusses the emotional appeal of the color scheme as a factor in selling cars and describes in detail a device, known as the Taylor color harmony keyboard, the purpose of which is to help the car builder in selecting harmonious color combinations. The recommendation is made that, for automobile painting, three colors be used which not only harmonize but which are widely different in character.

USE OF RUBBER IN AUTOMOBILE EQUIPMENT. By Charles Stuart. Published in *Motor Vehicle Monthly*, December, 1923, p. 36.

This paper lists and discusses uses of rubber in automobile equipment, other than tires, and illustrates these uses by photographs and drawings. The list includes (*a*) parts made from plastic or soft rubber, such as running-board step mats, heel mats, kick pads, front-compartment mats, rear or tonneau mats, brake and clutch-pedal pads, floor-board cut-out covers, shims for the body, radiator hose, spring bumpers, door bumpers, wind shield weather strips, arm-rest forms, binding, inserts and door stops; (*b*) parts made from composition or hard rubber, such as radiator-filler caps, gear-shift knobs, steering wheels, door handles and accelerator-pedal buttons.

TEMPERATURE REQUIREMENTS OF HOT-SPOT MANIFOLDS. By C. S. Kegerreis and O. C. Berry. Purdue University Engineering Experiment Station. Bulletin No. 15. Published by Purdue University, Lafayette, Ind. 43 pp.; 29 illustrations.

The introduction to this bulletin states that this investigation was undertaken to supply information on the temperature requirements of the hot-spot manifold and the

(*Continued on p.* 12)

BRIDGEPORT FABRICS

MR. BODY ENGINEER:

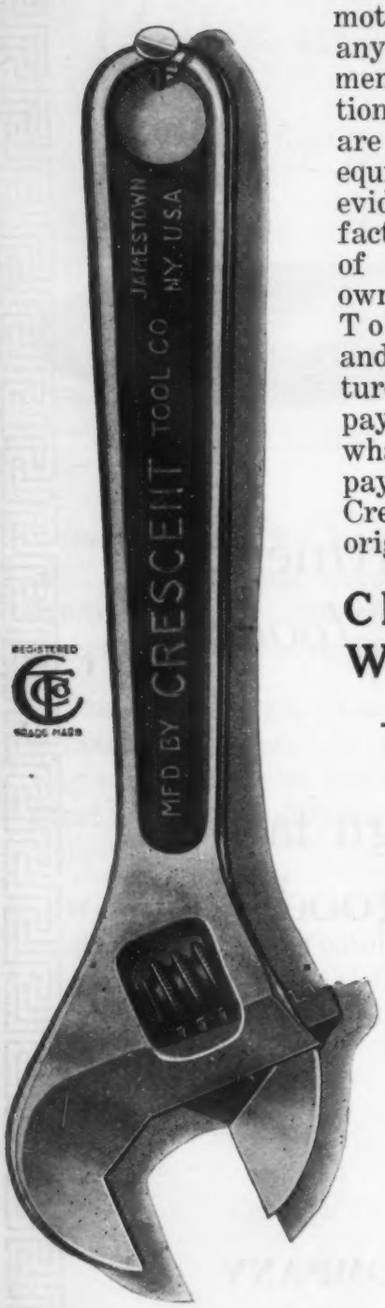
Often your Sales Department selects a fabric because it *looks* good.

It is our business to design fabrics that not only look good—but also *wear well*.

Our 1924 line is ready.

THE BRIDGEPORT COACH LACE COMPANY
Detroit, Mich. Bridgeport, Conn.

The outstanding choice of American motorists



The day is past when motorists accepted any kind of equipment without question. Nowadays they are motor-wise and equipment-wise. As evidence, consider the fact that a majority of American car-owners use Crescent Tools. Automobile and truck manufacturers are finding it pays to give buyers what they want. It pays to give them Crescent Tools as original equipment.

REGISTERED TRADE MARK

CRESCENT WRENCHES

—are used the world over

Special features of design and construction give Crescent wrenches a strength and dependability all their own. Bearings are sector cut (a patented method) and not broached. Handle is drop-forged from best carbon steel, hardened by special Crescent heat treatment. Seven sizes from 4 inches to 18 inches.

CRESCENT TOOL COMPANY

JAMESTOWN, N. Y.

Originators of the
CRESCENT WRENCH

NOTES AND REVIEWS

Continued

temperatures available in the engine-exhaust. Because of the two-fold objective, the experiments fall naturally into two groups: (*a*) the hot-plate tests and (*b*) the tests to determine the exhaust-gas temperatures of the automobile engine under different running conditions.

The object of the first group is the determination of three points: (*a*) the rate of vaporization per unit area for different fuels at various temperatures, (*b*) the temperatures at which the vaporization characteristics are most suitable for the purpose and (*c*) the point of deposition of solid matter.

The purpose of the second group is the testing of the effect of each of the following factors on the temperature of the exhaust gases: (*a*) the temperature of the cooling water, (*b*) the temperature of the inlet air, (*c*) the timing of the ignition, (*d*) the richness of the fuel mixture, (*e*) the speed of the engine and (*f*) the load carried by the engine.

The apparatus and the methods for the two groups of tests are described and results are summarized. The point is stressed that effort should be made to heat the fuel without heating the air, and in conclusion the authors state that one of the principal causes of the present poor carburetion lies in the improper manifolding of engines, adding that not only can our present commercial motor-fuels be used with better economy, but even heavier fractions can be properly carburetted by systematically utilizing the heat available in the engine exhaust.

THE VAPOR PRESSURES OF GASOLINES AND LIGHT PETROLEUM NAPHTHAS. By F. H. Rhodes and E. B. McConnell. Published in *Industrial and Engineering Chemistry*, December, 1923, p. 1273.

A method for the exact determination of the vapor pressures of gasolines and naphthas is described, and the vapor pressures of several different types of gasolines and naphthas are measured. It is shown that no general relation exists between the vapor pressure of a gasoline and its average distillation temperature or its density, and that the presence of air dissolved in the gasoline or naphtha may introduce into the vapor-pressure determination an error of considerable magnitude.

THE LUBRICANT AND ASPHALTIC HYDROCARBONS IN PETROLEUM. By Charles F. Mabery. Published in *Industrial and Engineering Chemistry*, December, 1923, p. 1233.

This work is a study of the hydrocarbons in petroleum which cannot be distilled without decomposition. The method used for their separation was fractional solution in a hot mixture of ether and alcohol, after first distilling the crude oil to 300 deg. cent. (572 deg. fahr.), first separating the homologs of each series and then dividing the series into fractions. Identification of the hydrocarbons was then accomplished by the determination of the specific gravity, the molecular weight and the percentage composition.

This method of separation and analysis was applied to five crude oils, from West Virginia, Pennsylvania, Ohio, Texas and Russia. The Ohio oil being one of peculiar composition, a study of its distillable constituents as well as of its fractions separated by solution is given. The homologs of the heavier series above 300 deg. cent. (572 deg. fahr.) vacuum appear to increase regularly and are divided into (*a*) the *D* hydrocarbons, lubricants to the final heavy ends, and (*b*) the *H* group, asphaltic in the heavy ends. A comparison of the various oils shows a well-defined distinction between the lubricant and the asphaltic hydrocarbons, and the higher specific gravity of the Texas and Russian lubricant hydrocarbons is due to their inherent structure. The wide variation in the specific gravity of individual fractions of the heavy crudes indicates the presence of carboxyl acids or esters. Iodine number determinations show that only the ring form of unsaturation applies to the lubricant hydrocarbons, and they do not appear to enter into the formalite reaction as applied by the Marcusson method.

(*Continued on p.* 14)

"Seeing IS Believing"

THE PROTECTOMOTOR

Not only removes all Road Dust, Sand and Grit from the air supply to the Carburetor and motor, but gives *Visible Proof* that it does it.

More Than 99.9% Efficient under all Conditions

Remove the outer shell from a Protectomotor that has been in service and you will observe that the outside is covered with road dust, sand and grit that would cause excessive wear on pistons, rings, cylinder walls, bearings and all other moving parts, while the inside of the filtering medium is perfectly clean and white as when placed in service. Cut out a section and place under a microscope and you will not be able to detect any sand or grit on the inside surface.

THE PROTECTOMOTOR IS MORE THAN AN AIR CLEANER

Keeps Out All the Dirt. Controls Air Temperature. Muffles Carburetor Noises

Made of Aluminum and other Rust Proof Material throughout. Has no moving parts to wear, get out of order and become noisy. Small in size, light in weight elegant in appearance.

DOES NOT RESTRICT THE AIR OR DECREASE HORSEPOWER. REQUIRES NO ATTENTION

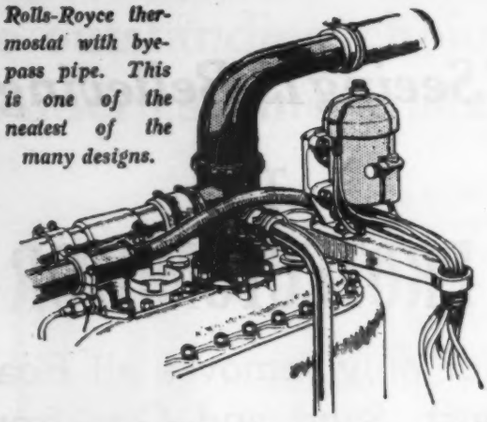
After careful tests in the best equipped laboratories and in the field for over three years, the Protectomotor has been adopted as standard equipment by some of the largest manufacturers of high grade automobiles, trucks and tractors.

Complete information on request.

STAYNEW FILTER CORPORATION

ROCHESTER, N. Y.

Rolls-Royce thermostat with bye-pass pipe. This is one of the neatest of the many designs.



Standard Equipment on the "Rolls-Royce," too!

The illustration shows a Sylphon Automobile Temperature Regulator installed on the famous Rolls-Royce. This car carries it as standard equipment.

Controlling the temperature of the cooling medium, it greatly reduces the wear of valves, pistons and cylinders. Reduces crank case dilution and carbon deposits to a minimum and saves from 15 to 20% in gasoline consumption.

Automobile Temperature Regulator

Simple, self-contained, it has but three main parts: the Sylphon Bellows—that seamless, solderless, flexible all-metal expansion member, which is the heart of all Sylphon products; a valve and a housing for the Sylphon.

The Sylphon is filled with a highly volatile liquid, which vaporizes at a predetermined temperature, expanding the Sylphon and opening the valve to admit water and contracting and closing the valve when the temperature falls.

Is self-regulating, adapted to pump or thermo-syphon cooling systems, can be installed between the radiator and the engine, either in outlet or inlet water connection. Has no moving parts to wear out, needs no oiling and will outlast the motor.

Standard Equipment on these leading Cars

Duesenberg	Packard
Flint	Pierce Arrow
Fiat	Rolls-Royce
Lincoln	Vauxhall
Napier	Vulcan Trucks

AND MANY OTHER CARS AND TRUCKS

Do not accept imitations or substitutes. We are the originators, patentees and sole manufacturers of Sylphon Regulators.

Send for Bulletin JUR.

THE FULTON COMPANY
KNOXVILLE, TENNESSEE

New York Chicago Detroit Boston Philadelphia

Representatives in all Principal Cities

NOTES AND REVIEWS

Continued

BALL-BEARING LUBRICATION. By Alexander Duckham. Published in *Engineering*, Nov. 16, 1923, p. 612.

This paper differentiates between plain bearings and ball bearings, as regards the problem of lubrication and shows that the ball bearing, although it does not wholly eliminate the need of lubrication, obviates some of the greatest difficulties, but at the same time introduces its own particular complications: (*a*) the need for a rust-preventing lubricant and (*b*) the need for either an oil-tight housing or a semi-solid lubricant. The three classes of semi-solid lubricants are discussed, and their desirable and undesirable features with reference to the lubrication of ball bearings are considered. Greases of the "vaseline" class, though widely used, are believed to be less desirable in connection with ball bearings than greases with a calcium base, while a caution is given with regard to the use in ball bearings of the third type of semi-solid lubricants, namely, that in which a grease of one of the types already mentioned is mixed with graphite or some other so-called solid lubricant.

PROBLEMS OF LUBRICATION RESEARCH. By Mayo D. Hersey. Published in *Journal of the American Society of Naval Engineers*, November, 1923, p. 648.

In the introduction the author states that some of the main physical problems of lubrication are the following: (*a*) the carrying power of an oil film, (*b*) journal friction under varied conditions, (*c*) thermal equilibrium, (*d*) viscosity under pressure and (*e*) oiliness. The paper consists of a discussion of each of the above-named points and concludes with a mention of unsolved problems that are continuations of the five general problems considered in the article.

PRESENT STATUS OF THE LOW-PRESSURE TIRE. Published in *India Rubber World*, Dec. 1, 1923, p. 153.

This article tells briefly of the development and characteristics of the low-pressure tire, states that 21 companies are now making them either experimentally or for the trade and emphasizes the fact that their great present need is standardization. In this connection certain standardization proposals are mentioned, including the following recommendation of the executive committee of the Rubber Association of America:

Rim In.	Tire Size In.	Cross-Section In.
21	29 x 4	4.40
21	31 x 5	5.25
21	33 x 6	6.20
20	32 x 6	6.20
20	34 x 7	7.30

INTERNATIONAL BALLOON-TIRE AND RIM STANDARDS ARE PROPOSED. By Colin Macbeth. Published in *Automotive Industries*, Nov. 8, 1923, p. 949.

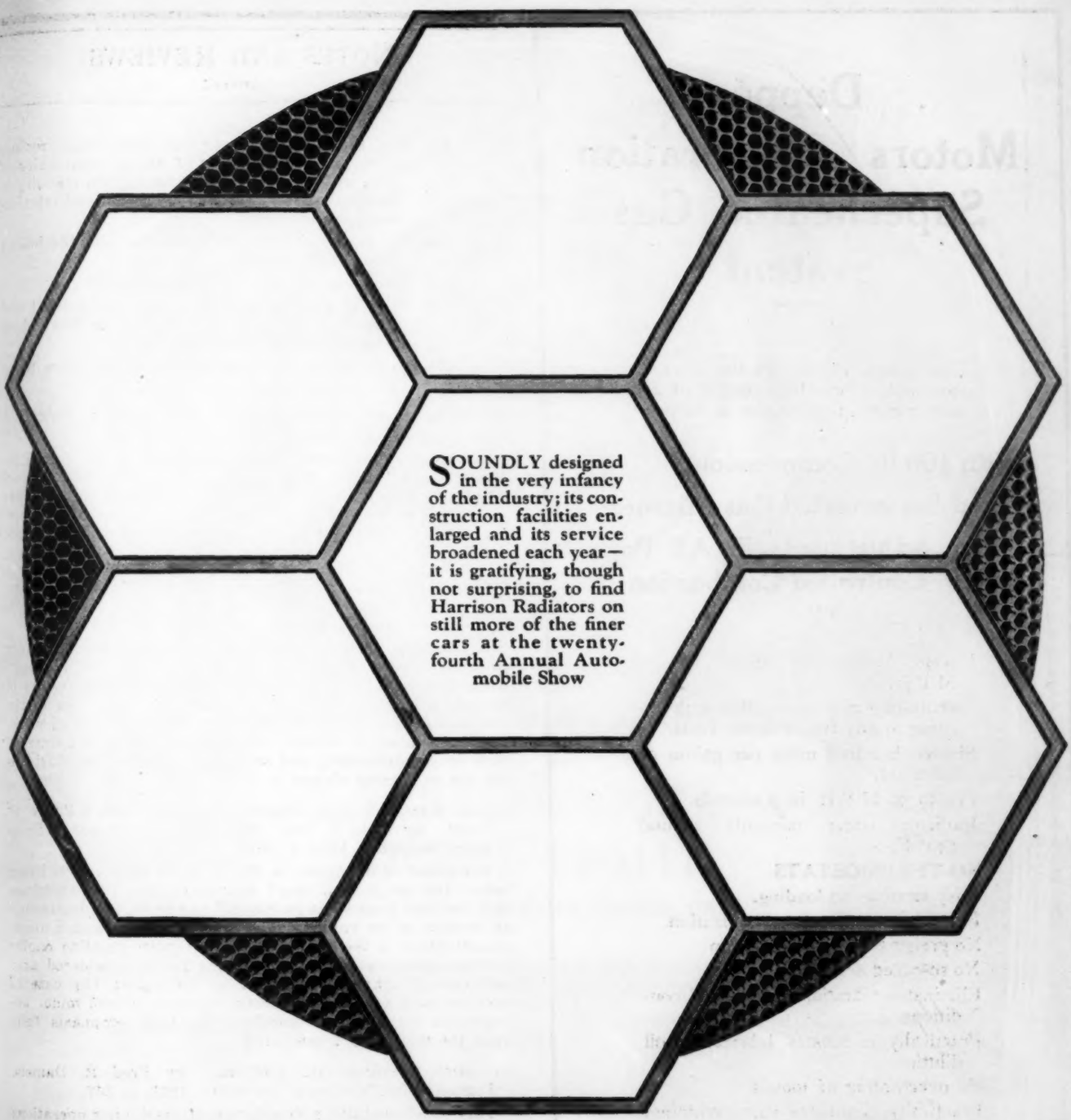
Pointing out the need for a universal standard as regards low-pressure tire dimensions, rim contour and valve connection, the author summarizes the disadvantages entailed by the use of the existing clincher and straightside equipment and suggests a range of five standard tires that fulfills certain requirements as to wheel diameter, rim width and tire sectional diameter. Low-pressure tires that are 29 x 4½, 30 x 5, 32 x 6, 34 x 7, 36 x 8 in. in size are recommended for small, light, medium-weight, heavy, and very heavy passenger cars respectively.

A summary of the points in favor of the proposed range includes the following:

(1) It is a real low-pressure range that, while giving a large increase in section, does not go so far as to hinder its adoption on new cars and in most cases makes conversion work on old cars easy

(2) Cost of such tires need not be any greater than that of normal tires

(*Continued on p.* 16)


SOUNDLY designed in the very infancy of the industry; its construction facilities enlarged and its service broadened each year—it is gratifying, though not surprising, to find Harrison Radiators on still more of the finer cars at the twenty-fourth Annual Automobile Show

HARRISON

Radiators

HARRISON RADIATOR CORPORATION

Lockport, New York

Deppé Motors Corporation Superheated Gas System

(Patented)

This system in cars of the 3000 lb. class with engine displacement of 250 cubic inches gives results as follows:

With 100 lb. Compression

Fixed Superheated Gas Mixture

Fixed Adjustments in All Parts with Controlled Combustion

Develop maximum speed of 60 M.P.H.

Twenty-two miles per gallon with existing or any future motor fuels.

Sixteen hundred miles per gallon of lubricant.

Ten to 30 M.P.H. in 9 seconds.

Radiator water normally around 130° F.

NO THERMOSTATS

Easy starting, no loading.

Practically eliminates carbonization.

No preignition, no autoignition.

No so-called detonations.

Eliminates vibration due to fuel conditions.

Practically eliminates lubricating oil dilution.

No overheating of metals.

Practically eliminates valve grinding.

Practically eliminates bearing adjustments.

Practically eliminates spark-plug troubles.

PRACTICALLY ELIMINATES GEAR SHIFTING.

Deppé Motors Corporation

151 Church Street

New York City

NOTES AND REVIEWS

Continued

(3) The faults inherent in standard high-pressure tires, namely, difficulty of fitting, complexity of rim, water damage, high rim weight, inability to stand abuse and valve complication and interference, are overcome

(4) The range of five tires submitted fills the bill in regard to diameter

(5) Oversizing can be carried out satisfactorily

(6) Tire and wheel manufacture will be simplified and there will be no interference with front-wheel brakes or center point steering

(7) No excessive bouncing or shimmying takes place when shock absorbers are not used

PROPOSED STANDARD NOMENCLATURE FOR GEARING. Published in *American Machinist*, Nov. 29, 1923, p. 801.

A report of the nomenclature committee of the American Gear Manufacturers Association includes the definition of 62 terms. These gearing definitions, accepted by the sectional committee of the American Engineering Standards Committee, are not submitted as recommended practice but are offered for study and criticism.

GERMAN STANDARDS FOR TOLERANCES AND ALLOWANCES IN MACHINE FITS. By Oscar R. Wikander. Published in *American Machinist*, Nov. 15, 1923, p. 733.

It is stated that the first question for each manufacturer to decide is whether he shall adopt the unit-bore or the unit-shaft system. The characteristic feature of each system is named, and considerations are stated that would lead to the adoption of the one or the other for different lines of work. The importance of properly selecting the grade and class of each fit is emphasized, and examples are given to illustrate the use of various classes of fits.

SMALL MARINE-ENGINE DESIGN FROM THE USER'S POINT OF VIEW. By Basil H. Joy. Published in *Automobile Engineer*, November, 1923, p. 343.

The object of the paper, as stated by the author, is to bring before the designer of small marine engines the difficulties that the user finds when he himself has to make adjustments or repairs to his engine. The type of engine under direct consideration is the four-cycle poppet-valve gasoline engine without any reversing gear, and the points considered are: (*a*) ease of manufacture, that is, the price; (*b*) ease of overhaul and (*c*) ease of access for more or less minor adjustments, repair or renewals. The chief emphasis falls upon the feature of accessibility.

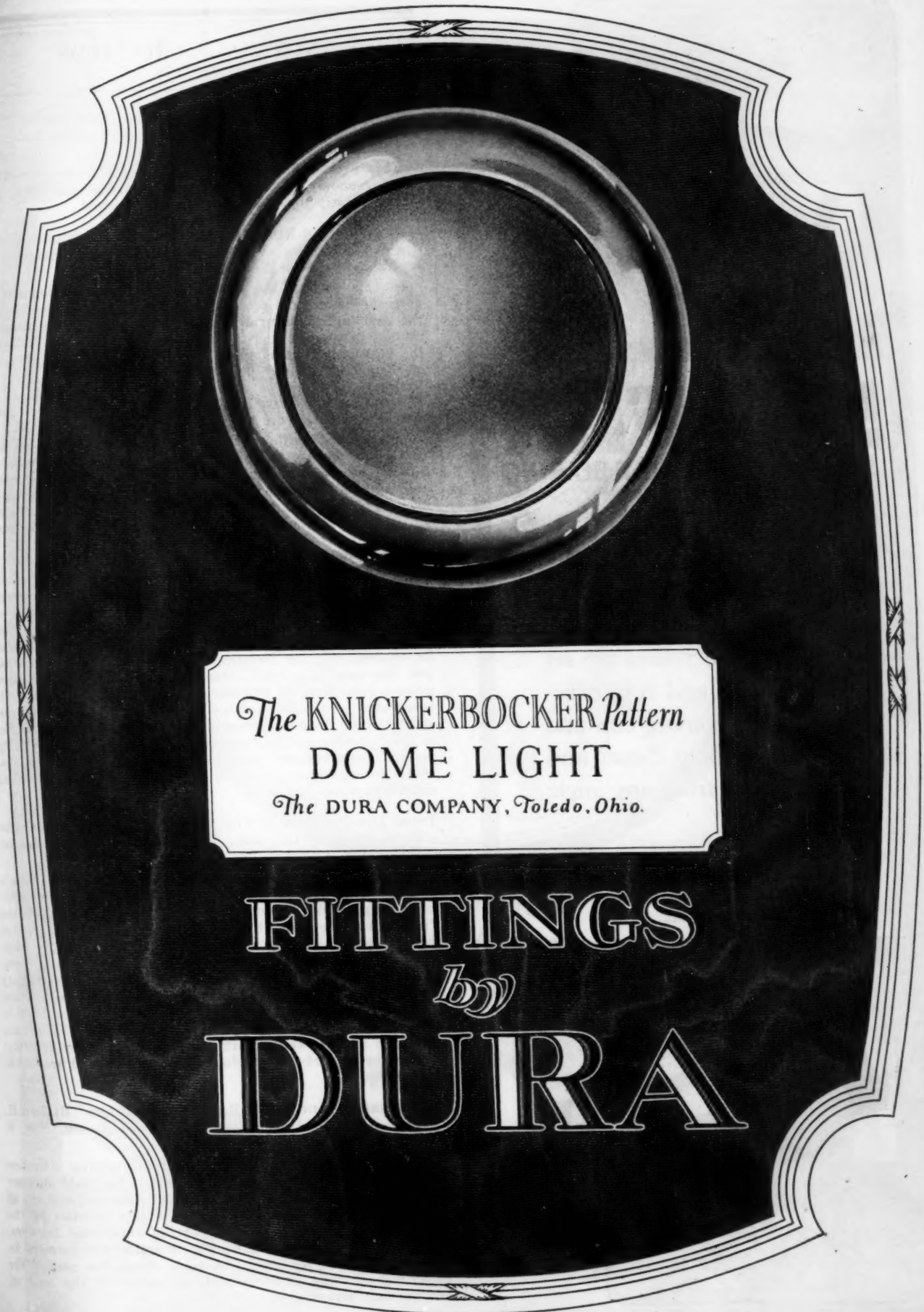
BUILDING VERTICAL OIL ENGINES. By Fred R. Daniels. Published in *Machinery*, December, 1923, p. 247.

This paper contains a description of machining operations on the engine bed, the frame, the crankshaft, the cylinder liner, the piston, the connecting-rod and the flywheel of a Diesel engine to illustrate how the machine-work on the main parts of such an engine differs from that performed on similar parts of smaller engines. The article is supplemented by 13 illustrations, including a sectional view of the engine through the cylinder frame.

WELDING ALL-STEEL AUTOMOBILE BODIES. By Joseph W. Meadowcroft. Published in *The Iron Age*, Nov. 29, 1923, p. 1457.

This extract from a paper, read before the Philadelphia section of the American Welding Society, describes the equipment and the methods employed in a plant building all-steel automobile bodies. Three methods of welding are used, each where it is best fitted, and special machinery and devices add to the quantity and the quality of production.

(*Concluded on p.* 18)


The KNICKERBOCKER Pattern
DOME LIGHT
The DURA COMPANY, Toledo, Ohio.
FITTINGS
by
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SHAFER
Self-Aligning ROLLER BEARING
PAT. & PATS. PENDING
Shafer Bearings are self-aligning and automatically compensate for shaft deflections.
The concave rollers are set at an angle, and rotate between the convex cup and cone; absorbing thrust and radial loads from any angle applied.
SHAFER BEARING CORPORATION
6501 WEST GRAND AVENUE
CHICAGO, ILL.

NOTES AND REVIEWS

Concluded

NEW HEAT-TREATMENT BATH PERMITS HANDLING OF PARTS IN FINISHED FORM. Published in *Automotive Industries*, Dec. 6, 1923, p. 1147.

This article briefly describes a new process for which great economy is claimed, one of the features being that comparatively unskilled labor can be utilized.

MODERN PISTON-RING PRACTICE INVOLVES EFFICIENT DESIGN AND PRODUCTION: PART I. By P. M. Heldt. Published in *Automotive Industries*, Dec. 6, 1923, p. 1142.

In this article, the author reviews the development of modern piston-ring practice. Topics discussed include (*a*) the securing of uniform pressure of the ring at all points of contact between it and the surface of the cylinder bore, (*b*) the best proportional width of rings and (*c*) the efficiency of compound rings.

TESTING OF STEEL FOR HARDNESS. By H. M. German. Published in *American Machinist*, Nov. 22, 1923, p. 769.

This paper, dealing with some of the most important factors and elements that introduce errors in the operation of hardness-testing machines, specifically the Brinell, the Rockwell and the scleroscope, states the principle of operation of each of these machines and their chief limitations and gives instructions for using them with the maximum of efficiency.

MOTOR SHOW REVIEW. An illustrated extra number of *Automobile Engineer*, published on Nov. 22, 1923. 32 pp.

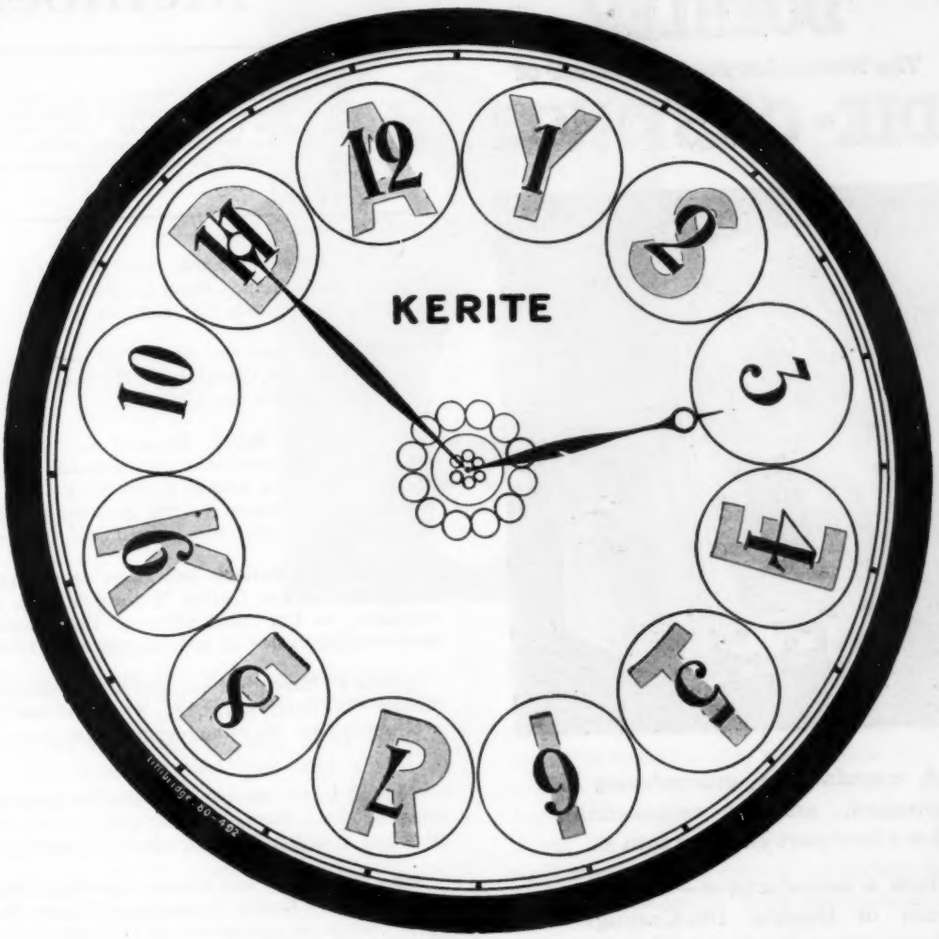
This extra number is concerned exclusively with the annual show at Olympia, Nov. 2 to 10, 1923. The editorial on Standard Models points out that the 1923 show was decidedly a salesman's show, as compared with previous years when its interest for the technical man was much greater than was the case this year. One page, entitled Show Review, gives a brief general summary of the trend of design. The remainder of the publication is devoted to a detailed consideration of the more interesting exhibits, which are treated in the following groups: engines, lighting and starting equipment, frames, clutches and clutch couplings, gearboxes, rear axles, springs and spring-suspensions, front axles, steering and front wheel brakes.

TRADE AND INDUSTRY OF FINLAND. Published by J. Simelius' Heirs Printing Co., Ltd., Helsingfors, Finland. 747 pp. Illustrated.

The preface indicates that this book is intended to form one link in a chain of propaganda that has seemed desirable to consolidate and extend the commercial relations between Finland and the English-speaking countries and states that the present compilation may be regarded as a reliable guide to the banks, insurance companies, manufacturers, commercial firms and ship owners of Finland. An introductory chapter of 46 pages gives a survey of economic and political conditions in Finland. The main portion of the book is devoted to descriptions of nearly 400 firms. There are indices of imports and exports, as well as an index of firms; among the imports are included motor cars and motor-car accessories.

AN EXPERIMENT IN EARTH ROAD CONSTRUCTION. By Ben H. Petty. Published in *Engineering News-Record*, Nov. 8, 1923, p. 754.

This is an account of an experiment in highway extension work made by Purdue University during the past summer in the southern part of Indiana. Short standard sections of earth road were constructed in each of six counties by the aid of volunteer labor on the part of interested farmers, these sections to serve as models to guide the farmers in extending the improvement. A table shows the cost of the experimental road improvement, exclusive of the cost of engineering supervision.



Time is the great test. The most efficient and permanent insulation known is

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DOEHLER

The World's Largest Producer of

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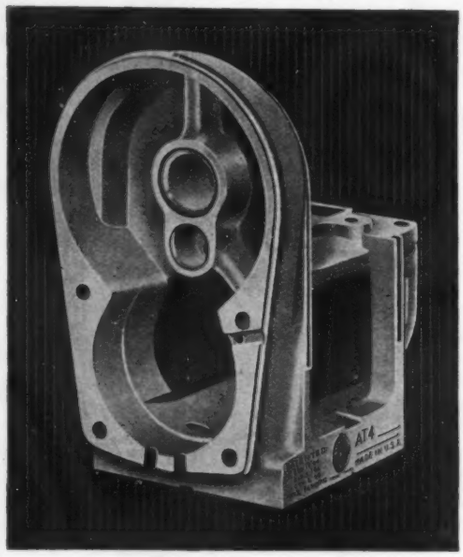

A manufacturer, guaranteeing his product, assumes responsibility for every part entering into it.

Such a manufacturer—if he be a user of Doehler Die-Castings—knows that he has back of the die-castings he uses, the reputation and resources and responsibility of the world's largest producer of die-castings.

He knows that Doehler Die-Castings are correct in design, honest in material and workmanship, and available to him at the time wanted in the quantity needed—without fail.

This is a part of Doehler "production insurance."

DOEHLER DIE-CASTING CO.
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TOLEDO. OHIO.

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

B. W. Ainsworth, who was formerly associated with the Durant Motors, Inc., Long Island City, N. Y., is now affiliated with the Locomobile Co., Bridgeport, Conn.

C. R. Armbrust has opened an office as consulting automotive engineer in Cleveland. He was previously engineer for the Gilman-Davis Co., Chicago.

Harrison H. Boyce, inventor of the moto-meter, has resigned as vice-president and general manager of the Moto-Meter Co., Long Island City, N. Y. He will in the future devote his attention to the promotion of his new product, Boyce-ite, the super-fuel ingredient.

Howard F. Bullock has been transferred from the New York office of the United Motors Service, Inc., where he was manager, to the main office of the company at Detroit, to perform the duties of special representative.

Albert C. Burch has severed his connection with the Courier Motors Co., Sandusky, Ohio, where he was president and general manager. No announcement has been made of his future plans.

Com. J. L. Callan has been elected director and president of Airships, Inc., Hammondsport, N. Y. He has been prominent in naval aviation for a number of years.

John R. Cautley has become associated with Vincent Bendix of the Perrot Brake Corporation, South Bend, Ind., and will be in charge of operations as vice-president and general manager of that organization.

Arthur E. Corbin, who was formerly associated with the York Motors Corporation, New York City, in connection with sales development, is doing similar work for the A. S. Nichols Co., also of New York City.

George M. Corbin, who was until recently resident inspector of engineering materials for the Lawrance Aero-Engine Corporation, New York City, has joined the production engineering department of the Wright Aeronautical Corporation, Paterson, N. J.

Fred A. Cornell was recently elected vice-president of the C. G. Spring Co. of Delaware, Detroit. He was formerly general sales manager for that company.

Valdemar N. Cronstedt has resigned as designing engineer for the Chance Vought Corporation, Long Island City, N. Y. His plans for the future have not been announced as yet.

William P. Crowell has been made sales manager and assistant to the president of the Mount Vernon Buick Co., Mount Vernon, N. Y. He was previously salesman and service manager for the Hudson Motor Car Co., also of that city.

(*Continued on p. 4*)

What *is* this new finish

DUCO represents the greatest advance yet made in the art of finishing automobiles.

Manufacturers everywhere have been seeking a finish that would retain the true tones of the original pigment in a smooth, satin-like surface of enduring beauty—resistant alike to the elements and to the abrasions encountered in service on the road.

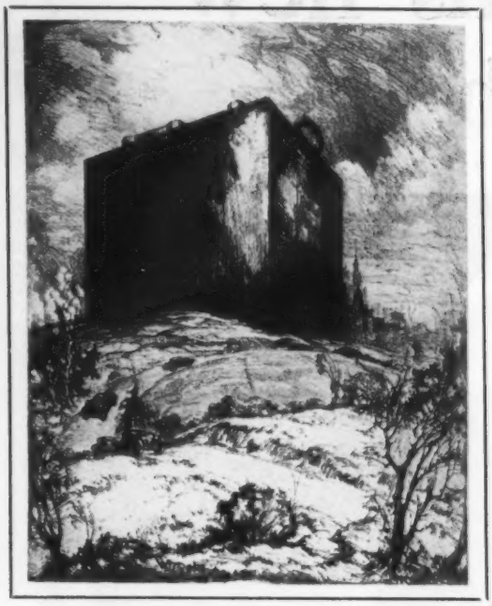
Duco—the result of years of research and development by du Pont chemists—combines at last these qualities. It is the most durable finish yet produced. Road tests prove conclusively that its beautiful lustre actually *improves with age.*

Due to its entirely new chemical composition, Duco has a hardness, durability and smoothness unapproached by any other material. It is impervious to sun, rain, snow, ice, grease or alkali dust—and is much less marred by bumps, scratches or other abrasions than any other finish. Its spray method of application and quick drying properties reduce time, space and investment in finishing product.

Duco is standard finish on all Oakland 1924 models, and, as a result of grueling service tests, many other manufacturers are arranging to adopt it.

E. I. DU PONT DE NEMOURS & CO., INC.
Chemical Products Division
PARLIN, N. J.

DU PONT
DUCO



Exide
BATTERIES

Combining maximum cranking ability with minimum size and weight, the Exide Battery has built up a host of satisfied users who recognize in its longer life and reliable performance those desirable characteristics for which they have always sought.

THE ELECTRIC STORAGE BATTERY CO.
PHILADELPHIA

Oldest and largest manufacturers in the world of storage batteries for every purpose.

Branches in All Principal Cities

Manufactured in Canada by Exide Batteries of Canada, Limited, 133-157 Dufferin St., Toronto.

PERSONAL NOTES OF THE MEMBERS

Continued

H. G. Diefendorf, who was formerly general manager of the Recording Devices Co., Dayton, Ohio, has purchased the steering gear division operated by that company.

J. J. Dimeo has been appointed factory manager for the Doehler Die-Casting Co., Batavia, N. Y. Until recently he was production manager for the Dura Co., Toledo, Ohio.

E. Favary is now consulting engineer for the Moreland Motor Truck Co., Los Angeles.

M. W. Gaffney has accepted a position as body engineer with the Fischer-Gaffney Body Co., San Francisco. He was formerly affiliated with the Ohio Body & Blower Co., Cleveland, in a similar capacity.

H. B. Garman, who was previously associated with the Garman Mfg. Co., Detroit, as general manager, has become sales engineer for the Universal Machine Co., Bowling Green, Ohio.

Victor Gauvreau has entered into a partnership to do business under the title of Govro-Nelson Co., Detroit.

S. W. Gray has become associated with the Wheeler-Schebler Carbureter Co., Indianapolis.

Edward W. Griffith, who was formerly sales manager for the Forsyth Bros Co., Harvey, Ill., has been appointed special representative for the Motor Wheel Corporation, Lansing, Mich.

E. H. Gunster has accepted a position as mechanical engineer for the Train Control Corporation of America, New York City. Prior to this he held a similar position with the Clifford Automatic Train Stop Co., Scranton, Pa.

Birger G. Gustafsson, who was previously tool and die designer for the Arvac Mfg. Co., Anderson, Ind., has become master mechanic for the Speedaumatick Co., Chicago.

W. K. Hadley has been made president of the Hadley-Wagener Corporation, New York City. He was until recently sales engineer for the Ludlum Steel Co., also of New York City.

Charles E. Hartrick has accepted a position as designer for the Yellow Coach Mfg. Co., Chicago. He was formerly automotive engine designer for the Yellow Sleeve Valve Works, East Moline, Ill.

James S. Henry is now draftsman and tool designer in the tool engineering department of the Peerless Motor Car Co., Cleveland. His previous business connection was with the Progressive Machine & Tool Co., Cleveland, doing drafting and tool and jig designing.

S. H. Jensen, who until recently was research engineer for the Monarch Governor Co., Detroit, has been elected secretary and treasurer of the Schieber & Jensen Mfg. Co., also of that city.

Albert E. Koeckert is now designer of special machinery and automatic production equipment for the T. J. Trundle Engineering Co., Cleveland. He was formerly associated with the Mechanical Rubber Co., which is also located in that city.

A. Ward LaFrance has severed his connection with the Walker Motors, Inc., New York City, of which he was vice-president.

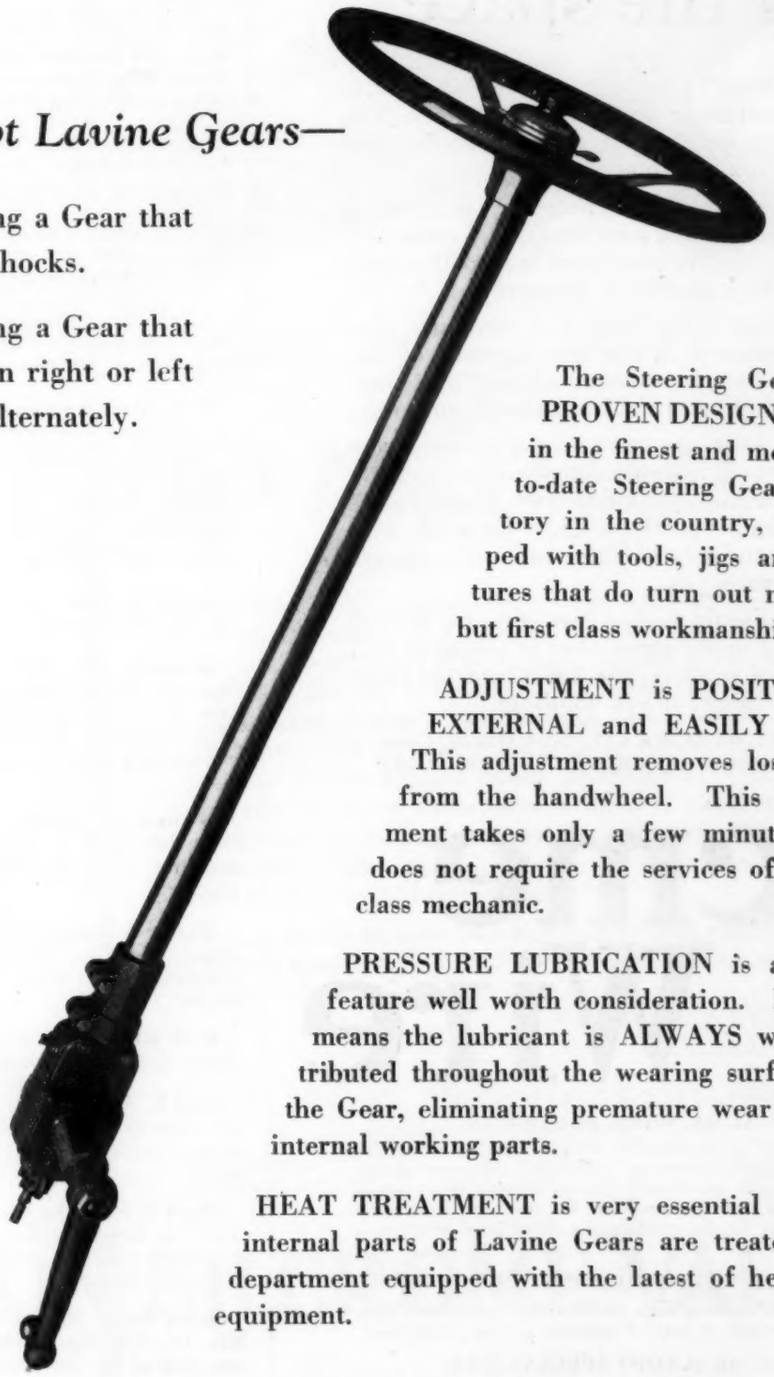
(*Continued on p. 6*)

Long Life Safety Low Maintenance Cost

When you adopt Lavine Gears—

You are getting a Gear that absorbs road shocks.

You are getting a Gear that can be used on right or left hand drives alternately.



Slight turn of adjusting screw gives proper adjustment and road feel.

The Steering Gear of PROVEN DESIGN, built in the finest and most up-to-date Steering Gear Factory in the country, equipped with tools, jigs and fixtures that do turn out nothing but first class workmanship.

ADJUSTMENT is POSITIVE—EXTERNAL and EASILY made. This adjustment removes lost play from the handwheel. This adjustment takes only a few minutes and does not require the services of a first class mechanic.

PRESSURE LUBRICATION is another feature well worth consideration. By this means the lubricant is ALWAYS well distributed throughout the wearing surfaces of the Gear, eliminating premature wear on the internal working parts.

HEAT TREATMENT is very essential and all internal parts of Lavine Gears are treated in a department equipped with the latest of heat treat equipment.

THE LAVINE GEAR COMPANY

60-80 Keefe Ave. Milwaukee, Wis.

"It goes in the space"

Acme Wire "goes in the space," smoothly, easily, without any kinks or bulges. The last turn does not have to be forced and hammered into place.

It goes in the space because it is uniform, free from lumps, bare spots, and other imperfections. Its insulation is smooth, even, and of high dielectric strength.

Back of Acme Wire is a company that has pioneered in the development of fine silk- and cotton-covered enamel wire since the beginning of the magnet wire industry.

Back of it, too, are years of investigation and research in developing wire that exactly meets winding conditions. Acme knows these conditions thoroughly, for in our own plant hundreds of thousands of coils are wound each year.

The slightly higher cost of Acme Wire is returned many times over in the increased output of winders, the fewer rejected coils, and the longer life of windings.

THE ACME WIRE CO., New Haven, Conn.
NEW YORK CHICAGO CLEVELAND

Acme Wire

ACME WIRE PRODUCTS

"Enamelite," plain enameled Magnet Wire; "Cottonite," Cotton-covered Enamelite; "Silkenite," Silk-covered Enamelite; Single and Double Cotton Magnet Wire; Single and Double Silk Magnet Wire. We also have a complete organization for the winding of coils in large production quantities.

ACME VARNISHED INSULATIONS

Varnished Cambrics, Silks and Papers, Varnished Tapes in rolls; straight or bias. Varnished Tubing (Spaghetti).

ACME RADIO SPECIALTIES

Audio Transformer windings; Radio Frequency windings; Magnet windings for Head Sets; Enameled wire—especially the finest sizes, 40-44 B & S gauge; Silk and cotton-covered magnet wire; Enameled Aerial wire, single wire and stranded.

Illustrated Catalog on request to Engineers, Purchasing Agents, Executives, and Operators.

PERSONAL NOTES OF THE MEMBERS

Continued

A. A. Lane resigned on Jan. 15 as engineer for the Francisco Sugar Co., New York City. His plans for the future have not been announced.

M. P. Laurent is associated with Laurent & Curlee, Houston, Tex., in charge of the Airline power tire pump, invented by him. His previous business connection was with the Southern Motor Mfg. Association, which is also located at Houston, in the capacity of chief engineer.

C. A. Musselman has been elected president of the Chilton Co., Philadelphia. Prior to this he was treasurer and general manager of the company.

Leroy Owen has been made works engineer for the H. A. Douglas Mfg. Co., Bronson, Mich. He was formerly works manager for the International Harvester Co., Chicago.

C. H. Parr, who was until recently engineer for the Hart-Parr Co., Charles City, Iowa, is now chief engineer for the Elgin Street Sweeper Co., Elgin, Ill.

R. E. Patten has accepted a position as detail designer for the Packard Motor Car Co., Detroit. He was formerly body designer and artist for the Cadillac Motor Car Co., also of Detroit.

Walter C. Peterson has been appointed metallurgist and sales engineer for the Standard Automotive Parts Co., Muskegon, Mich., and the Fredericksen Co., Saginaw, Mich.

W. R. Provoost has become affiliated with the Safe Cabinet Co., New York City.

Warwick Ray was transferred to the main office of the Stewart-Warner Speedometer Corporation, in Chicago, on Dec. 1, to take general charge of sales engineering. He has been located at Detroit since Jan. 1, 1919, handling the sales engineering work in the Michigan territory for this organization.

William C. Rowles has severed his connection with the Belle Isle Boat & Engine Co., Detroit, where he was works manager. No announcement has been made of his future plans.

Walter J. Rudolph, formerly chief engineer for the Imperial Brass Mfg. Co., Chicago, is no longer associated with this company. His plans for the future have not been made known.

R. S. Russell has been appointed engineer for the Roamer Motor Car Co., Kalamazoo, Mich.

Paul F. Schlick, who was until recently draftsman for the Minneapolis Steel & Machinery Co., Minneapolis, has been made vice-president of the American Supply Co., St. Paul, Minn.

Floyd B. Selensky has accepted a position as draftsman for the P. B. Yates Machine Co., Beloit, Wis. He previously held a similar position with the National Safety Devices Co., Waterloo, Iowa.

Harry Selker has been elected president of the Selker Brass Mfg. Co., Cleveland. He was formerly president and general manager of the Buckeye Brass & Mfg. Co., also of that city.

Harry G. Smith has become affiliated with the Nordyke & Marmon Co., Indianapolis, as designer. Prior to this he was engineer for the Holley Carbureter Co., Detroit.

H. A. Soulis, who was formerly mechanical engineer for Ryan & Dippel, New York City, has accepted a position with the International Motor Corporation, also of New York City.

(*Concluded on p.* 8)

Champions!

THOMPSON Silcrome Valves were in the 500 H. P. Curtiss D-12 engine that won the international speed races at St. Louis, averaging 243 miles an hour for 200 kilometers. They are also standard equipment in the Wright motors which set the new 300-hour full-throttle endurance standard now employed by the United States government. Thus designers of finest aeronautical motors confirm the judgment of leading automobile engineers who have specified Thompson Silcrome Valves because they are practically indestructible.

Let us prove, in your own test engines, the ruggedness of this moderately priced valve which hottest motors cannot destroy.

—built by a "trail-breaker of industry"

THE STEEL PRODUCTS COMPANY

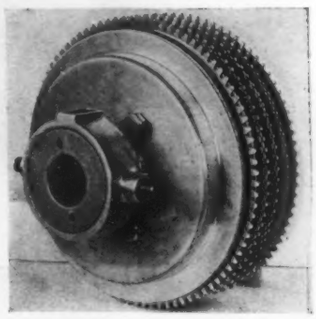
Also manufacturers of king bolts, shackle bolts, tie rod bolts, drag links, starting cranks, and brake rod assemblies

Main Plant
CLEVELAND

Michigan Plant
DETROIT

THOMPSON SILCROME VALVES

SP



Multiple Disc Clutches

"DETLAFF"

FROM the viewpoint of the Motor Vehicle Owner (the *real Boss* of our Industry), the most desirable—certainly the most important—function of the Detlaff Multiple Disc Clutch is in the *progressive* or *consecutive* engagement of the several driving discs, assuring a gradual increment of motion and forming a real cushion of protection for transmission and axle parts, against sudden and destructive engine shocks.

THIS *softness* of *action* is undoubtedly one of the principal reasons for the remarkable mileage records of cars equipped with Detlaff Multiple Disc Clutches. In the long run—because they create *"Good-Will"* and *Reputation*—these Multiple Disc Clutches are the least expensive type.

OUR 1924 catalog with descriptive illustrated text is available at Detroit and Chicago. If you haven't one we will mail your copy on request.

MODEL "D" Heavy Duty Clutch is new and highly efficient for buses, heavy trucks and gas locomotives.
For high speed engines we have the new passenger car model "M-4-4," light in weight, balanced and easily adjustable.

DETLAFF Clutches are designed for Maximum Dependability and manufactured by Clutch Specialists.

A. J. DETLAFF CO.

Detroit, Mich.

PERSONAL NOTES OF THE MEMBERS

Concluded

G. F. Stephenson has opened the Venice Radio Shop, Venice, Cal. He was previously manager for the E. P. Cooper Co., Los Angeles.

W. E. Arthur Todd has severed his connection with the Beaver Truck Corporation, Ltd., Hamilton, Ont., Canada, where he was assistant to the chief engineer. His future plans have not been announced.

Fred I. Tone has become affiliated with the Gordon-Dexter Co., St. Clair, Mich.

Harry Unwin has been appointed general manager for J. H. Caster, Inc., Buffalo.

A. F. Wagner, who was until recently chief engineer and production manager for the Arecibo Grape Fruit Co. of Porto Rico, now holds a similar position with the Southern Citrus Products Co., Lakeland, Fla.

Emmet I. Walsh has accepted a position as designer for the Baker R & L Co., Cleveland. He was formerly associated with Weaver & Kemble, also of Cleveland.

Harry G. Welfare, who was formerly manager in charge of sales for the McAllister Co., Cleveland, has been made vice-president and sales manager of the Sterling Electrical Corporation, which is also located in that city.

E. F. Wheat has organized the Tillman Auto-Electric Co., Springfield, Mo., and is acting in the capacity of manager.

Joseph L. White, having sold his interests in the Hewitt & White Co., Oakland, Cal., is no longer connected with that company, but has joined the engineering department of the Western Union Telegraph Co., and is stationed at San Francisco.

Stanley Whitworth, who was formerly assistant manager for the Stutz Motor Car Co. of America, Indianapolis, has become associated with the Sheldon Axle & Spring Co., Wilkes-Barre, Pa.

Raymond N. Wing is now mechanical engineer for Bley & Lyman, Buffalo. He was previously proprietor of the Compression Tube & Tire Co., also of Buffalo.

C. H. Yackey has been promoted from assistant chief engineer to general superintendent of the Gardner Motor Co., St. Louis.

John Younger, who was until recently vice-president and assistant general manager of the Standard Parts Co., Cleveland, is now editor and publisher of *Automotive Abstracts,* which also is located in that city.

New Process Gear Company

Incorporated

Differential Gear Mfrs.

Syracuse, N. Y.

Gears made of stabilized Celoron are light, strong, and durable. In operation they are permanently positive and silent.

The fabric gear material that does not swell

A SILENT gear that *stays* silent can be made only from a stabilized material.

If the material increases in thickness, cross bearings develop in the gear teeth and an irritating noise results.

Celoron has been stabilized.

Before the sheets are cut into gear blanks, a special treatment removes all danger of noise through swelling of the finished gear even in the hot oil of the timing gear case.

Celoron Silent Timing Gears can be used in any timing gear set. They already are standard equipment on Marmon, Jewett, Nash, Maxwell, Oldsmobile, Gardner, Apperson, Courier (Falls Motor), Dorris, Dort, Elcar, Handley (640), Haynes (55), and are available for Buick replacements.

Celoron is made of layers of woven fabric, thoroughly impregnated with condensite gum. Under tremendous pressure and intense heat, these sheets of fabric are bonded into a tough, hard, durable material. Celoron is known technically as "the laminated phenolic condensation material, bonded with condensite."

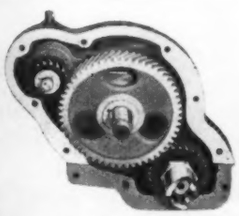
Gears made of Celoron are strong, light, and long-wearing. They are permanently positive and silent in operation.

Celoron Silent Gears, properly mated and installed, do not develop snarls, grinds, or howls, even with long use in timing gear cases.

Our laboratory and engineering service is at your disposal without charge or obligation. We shall be glad to supply you with full information on the uses of Celoron and Diamond Fibre in the manufacture of motor cars and production machinery. Write to Dept. 41.

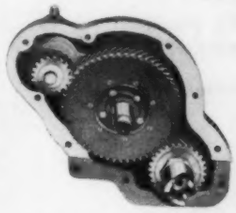
DIAMOND STATE FIBRE COMPANY
Bridgeport, Pennsylvania
(near Philadelphia)

Branches in Principal Cities
Toronto, Canada London, England



Celoron Crank and Generator Gears

CELORON
SILENT TIMING GEARS



Celoron Cam Gear

Make Celoron Silent Timing Gears standard equipment on all your future cars

the typical car-owner is 33 years old, and

—is married.
—has a bank account and carries life insurance.
—buys a $1400 car and pays $700 down, paying $100 a month on the balance.
—has monthly income of $350.
—has owned a car before.

These are conclusions of a Cleveland financial concern. In addition (as shown by Crescent sales figures)

he prefers
CRESCENT TOOLS

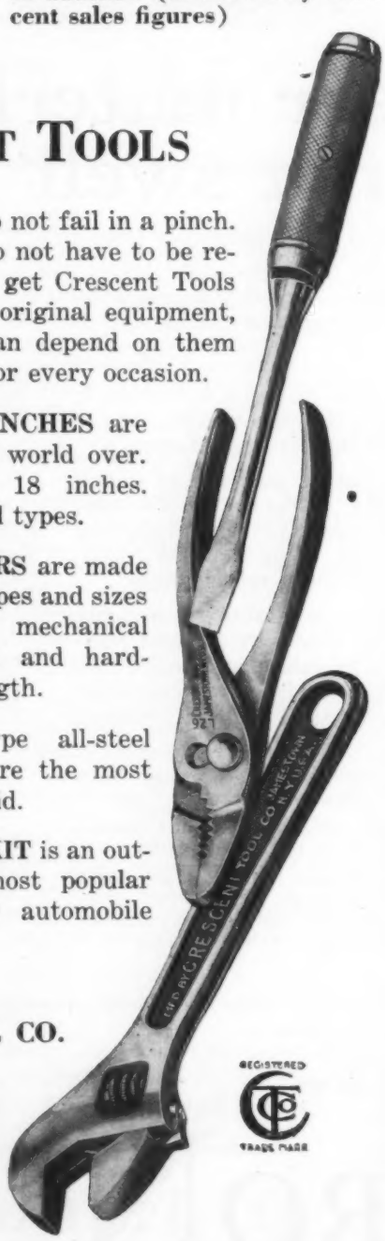
He likes tools that do not fail in a pinch. He likes tools that do not have to be replaced. He likes to get Crescent Tools with his new car as original equipment, and know that he can depend on them day in and day out for every occasion.

CRESCENT WRENCHES are known and used the world over. Sizes 4 inches to 18 inches. Single and double end types.

CRESCENT PLIERS are made in a wide range of types and sizes for every sort of mechanical work. Drop forged and hardened for extra strength.

CRESCENT T-type all-steel **SCREWDRIVERS** are the most powerful of their kind.

The **CRESCENT KIT** is an outfit of the three most popular Crescent Tools for automobile and general use.



CRESCENT TOOL CO.
213 Harrison Street
JAMESTOWN, N. Y.

Originators of the Crescent Wrench

CRESCENT TOOLS

Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

MECHANICS OF THE GASOLINE ENGINE. By H. A. Huebotter. Published by the McGraw-Hill Book Co., Inc., New York City. 313 pp.; illustrated.

In this book the principles of the mechanics of materials have been applied to the solution of general problems of engine design in such a way as to illustrate the procedure and simplify the work for specific cases. The preface states that the work is submitted more for the convenience of the designing engineer than for the instruction of the layman. Stressing the importance of the ability to apply basic principles to concrete problems in a practical manner, the author mentions as his aim the pointing out of these principles and the employment of them in mathematical analysis in such a way as to enable the novice to build up his judgment about them rather than about a mass of equations that are of no value except in the particular cases for which they were derived. Representative units of various kinds of engines are illustrated and in some cases analyzed.

CONDENSED CATALOGS OF MECHANICAL EQUIPMENT WITH GENERAL CLASSIFIED DIRECTORY AND CONSULTING ENGINEERS DIRECTORY. 13th annual volume, 1923 and 1924. Published by the American Society of Mechanical Engineers, New York City. 678 pp.; illustrated.

The preface states that this work serves as a handy substitute for individual catalogues when they are not on file, as a ready index when they are and as a basis of inquiry for complete catalogs when required. The book contains over 30,000 listings of manufacturers and products, carefully classified and cross-indexed so as to be of the greatest possible service to the user.

INDUSTRIAL OIL ENGINEERING. By J. R. Battle. Published by J. B. Lippincott Co., Philadelphia. 1142 pp.; illustrated.

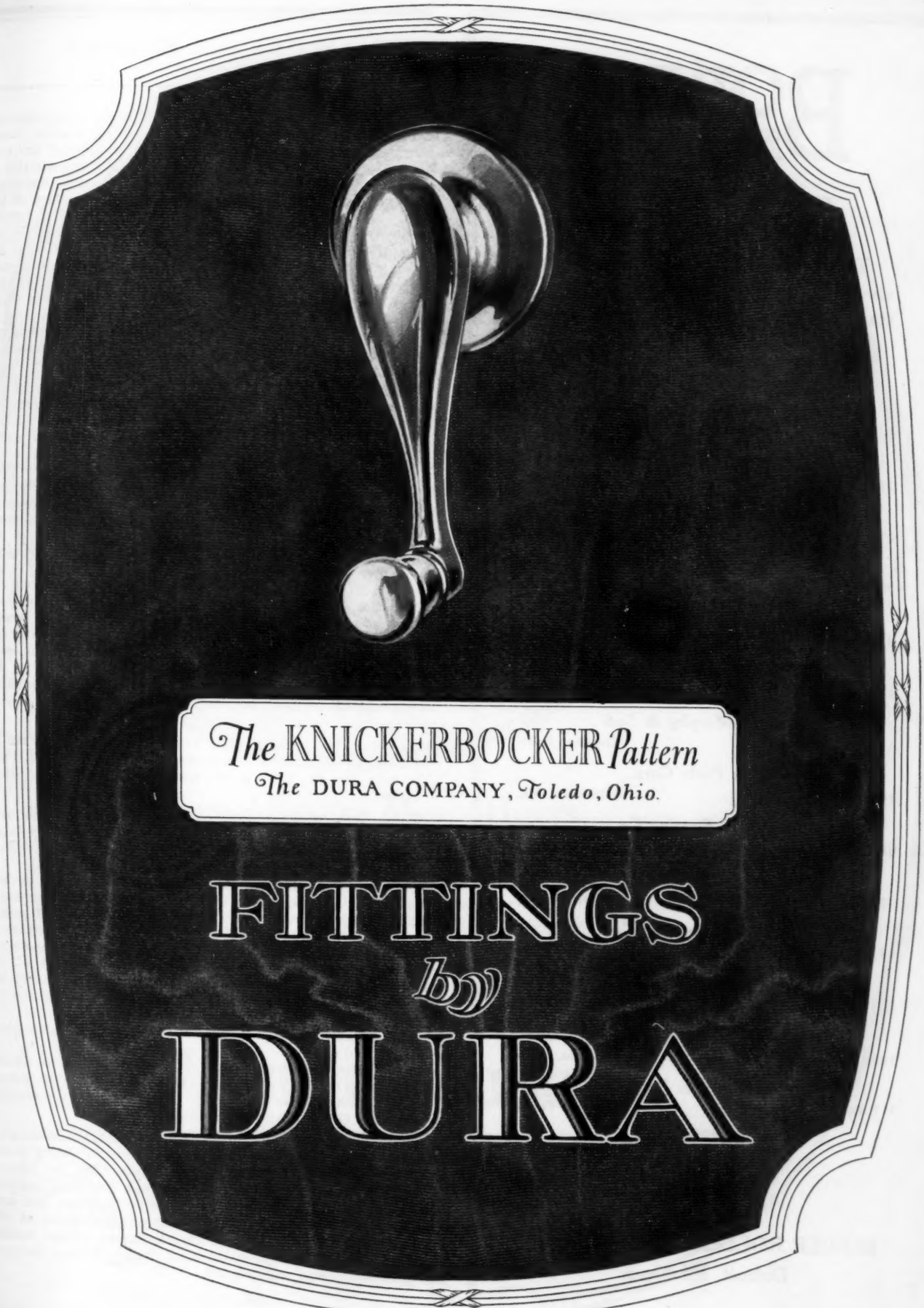
This volume is a revision of the second edition which was issued in 1920. Notable improvements are the amplification of Section 11-d, and the addition of two new sections, 11-e and 11-f. In Section 11-d United States Government Specifications for gasoline are brought uptodate. Section 11-e contains United States Government Specifications for naphthas and burning oils, and Section 11-f is devoted to conversion tables for petroleum oils, showing American Petroleum Institute degrees, corresponding to specific gravity at 60 deg./60 deg. fahr., specific gravity at 60 deg./60 deg. fahr. corresponding to American Petroleum Institute degrees and American Petroleum Institute degrees corresponding to degrees Baume. The introduction to the tables calls attention to the fact that there have been in use in the petroleum industry two arbitrary scales for hydrometers, one based upon the Modulus 140 and the other based upon the Modulus 141.5. To avoid confusion, misunderstanding and uncertainty, the American Petroleum Institute, the Bureau of Mines and the Bureau of Standards agreed upon the Modulus 141.5, to be used in the United States petroleum industry and to be known as the American Petroleum Institute scale. The tables are based upon the formula:

$$\text{American Petroleum Institute degrees} = 141.5 \div (\text{Specific Gravity at 60 deg./60 deg. fahr.}) - 131.5$$

THE COMMERCIAL MOTOR TRANSPORT EXHIBITION AT OLYMPIA. Published in *Engineering*, Nov. 23, 1923, p. 660; Nov. 30, 1923, p. 690 and Dec. 7, 1923, p. 705.

Evidence of the advance made recently in the design and construction of commercial motor vehicles in the United Kingdom is given in these articles describing the exhibition held in London last November.

(Continued on p. 12)


The KNICKERBOCKER Pattern
The DURA COMPANY, Toledo, Ohio.
FITTINGS
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BOWER
ROLLER BEARING CO.
Detroit Michigan

Bower Service

The following organizations carry a stock of Bower Roller Bearings and stand ready to render service at all times.

Auto Equipment Company
1021 N. Meridian St. Indianapolis, Ind.

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2711 Michigan Avenue Chicago, Ill.

Detroit Ball Bearing Company
3958 Cass Ave. Detroit, Mich.

Fenstermacher Automobile Sup. Co.
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1834 Broadway New York, N. Y.

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1419 No. Charles St. Baltimore, Md.

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Northwest Bearing Co.
601 East Pike St. Seattle, Wash.

Pacific Ball Bearing Co.
415 West Pico St. Los Angeles, Cal.

Southern Bearing Co.
375 Edgewood Ave. Atlanta, Ga.

Standard Bearings Co.
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Western Gears & Parts Co.
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BOWER ROLLER BEARING CO.
Detroit, Michigan

NOTES AND REVIEWS
Continued

The exhibits, many of which are discussed and illustrated by numerous drawings, include taxicabs, fire engines, buses, steam wagons and electric trucks. The last-named are used extensively in England by corporations for the collection of garbage, as the batteries can be recharged at the municipal generating stations at very slight cost during hours of low load. One exhibit that will appeal to those who are interested in the work of the Associated Equipment Co., as exemplified in the London General Omnibus chassis, is the new A. E. C. model designed for use in carrying either passengers or freight. This chassis will handle a net load of 2 tons or a gross load, including the body, of 2¾ tons. The aim of the designers was to keep down the price and to insure a low cost of operation by simplifying the design and reducing the number and the complexity of the component parts.

The Super-Sentinel Steam Wagon, with a carrying capacity up to 10 tons, is described and the distinctive features of the machinery are illustrated by drawings of the boiler and the engine. The fuel used is gas coke on account of its cheapness, but hard coal or charcoal is equally suitable. A new four-wheel drive truck chassis, known as the 3-ton F.W.D. motor lorry, has interesting and unusual features and has aroused much discussion in England where the application of this type of drive to motor trucks is a novelty. As the system of driving is so unusual, illustrations of the chassis and the construction of the transmission components are shown in considerable detail on pp. 706 and 707 in the third article of the series. Another interesting group of illustrations on pp. 710 and 711 shows some of the important details of a Maudslay chassis specially designed for service in passenger carrying, and no less noteworthy is one of the Thornycroft exhibits, the J-type double-deck omnibus, conspicuous for the care that has been expended upon its design. The bus body fitted to this chassis at the Exhibition was designed to meet all the requirements of the Metropolitan Police for service in London.

WHAT FORD HAS DONE IN THE LINCOLN PLANT. By Fred H. Colvin. Published in *American Machinist*, Dec. 20, 1923, p. 897; Dec. 27, 1923, p. 943 and Jan. 3, 1924, p. 5. Illustrated.

These three articles point out some of the methods used in the Lincoln plant. To illustrate the care that is taken in machining, inspecting and assembling, the author chooses certain operations and describes them in detail.

The topics selected for consideration include the various operations connected with the production of the crankcase and the transmission; methods of honing cylinders, of polishing gear teeth and of holding the piston-pin in the piston; devices for holding the camshafts straight and true during the hardening process, for testing the alignment of the piston and the crankshaft bearing at the other end of the rod, for putting the locking pin in place, for putting the pin in the valve-slide roller and for putting the piston-rings into their respective grooves; as well as various assembling methods and devices.

ANNUAL REPORT OF THE DIRECTOR OF THE BUREAU OF STANDARDS TO THE SECRETARY OF COMMERCE, FOR THE FISCAL YEAR ENDED JUNE 30, 1923. Published by Government Printing Office, City of Washington. 330 pp.

Topics of particular interest to the automotive industry are discussed on pp. 104 to 111, under the following heads: altitude laboratory, ignition, carburetion, fuels for internal combustion engines, lubrication, cooling problems, automobile brake-linings, road performance of engines and cars, mechanical efficiency of truck rear-axles, phenomena of combustion and miscellaneous. This last-named section includes a mention and a brief description of certain devices that have been designed and constructed.

(*Continued on p.* 14)

When Minutes Mean Hours

WHEN the fire alarm rings, even a slight delay in starting the fire apparatus may mean hours of time in putting out the blaze.

Stutz Fire Engine Company has recognized this fact. Every part of Stutz Fire Apparatus must be of utmost dependability and ready for service at all times.

Realizing the importance of reliability in starting and lighting equipment, Stutz selects Westinghouse to furnish these two important units.

Westinghouse starting, lighting and ignition apparatus is the choice of manufacturers of motor cars and trucks, in every price class. The engineers of this world-wide organization are always ready to help solve *your* electrical problems.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Automotive Equipment Department - Sales and Service Headquarters: 82 Worthington Street, Springfield, Mass.

Westinghouse

Gar Wood Says:

"That over 90% of all truck makers advise Wood-Detroit Dumping Equipment is due to its superior design; that over 90% of users specify Wood-Detroit is proof of its superior service."

Gar Wood

Built by "Gar" Wood

Friction losses and lubrication problems are insignificant with only three moving parts—a piston and two pump gears—at all times working in oil, in

WOOD DETROIT

Hydraulic Hoists

The serviceability that this simplicity and efficiency has given to Wood-Detroit Hoists and the sturdiness of these units and of the Wood-Detroit Steel Bodies, is responsible for their leadership since the earliest days of the industry.

Wood Hydraulic Hoist & Body Company

7924 Riopelle St. Detroit, Michigan

Sales and Service in Principal Cities

NOTES AND REVIEWS

Continued

AUTOMOTIVE INDUSTRY SHOULD LEAD IN SAFETY MOVEMENT. By C. W. Price. Published in *Automotive Industries*, Dec. 13, 1923, p. 1187.

The need for action in the prevention of traffic accidents on economic as well as humanitarian grounds is stressed, and five reasons based on economic principles are given to show why the automotive industry should take the lead in the safety movement.

HIGHWAY OFFICIALS REVIEW TECHNICAL ACTIVITIES OF 1923. Published in *Engineering News-Record*, Dec. 13, 1923, p. 982.

The papers presented in New Orleans at the convention of the American Association of State Highway Officials, Dec. 3 to 6, are summarized under the heads of administration turnover, federal-aid, design and research, finance and construction.

WHAT CAR-OWNERS SHOULD PAY FOR ROAD BUILDING. By A. R. Hirst. Published in *Engineering News-Record*, Dec. 13, 1923, p. 967.

This paper proposes the following formula for figuring vehicle imposts: "The motor-vehicle owners of each state should each year pay for their highway service one-half of the total amount made available in that year to pay the cost of the state's highway program, after deducting from said amount the total amount made available to pay the cost of the state's highway program in the year 1904." The reason given for selecting 1904 as the basing year is because dependable figures of highway expenditures in all states are available for that year and because it marks the real beginning of the motor era. The various common forms of taxation upon motor vehicles are briefly summarized, and the opinion is expressed that the motor-fuel tax is the most scientific of them.

TAKING THE GUESS OUT OF ROAD-BUILDING. By William Atherton DePuy. Published in *American Motorist*, December, 1923, p. 20.

This account of the part played by research in the development of road-building as a science mentions tests that have been conducted and instruments that have been devised, with special emphasis on the work of this nature carried on by the Bureau of Public Roads. The traffic counter, the accelerometer and the strain gage are among the instruments described, and considerable attention is given to the building of experimental sections of road as a factor in highway improvement.

REFINEMENTS MARK CHASSIS DEVELOPMENT. By R. E. Plimpton. Published in *Bus Transportation*, January, 1924, p. 9.

This review of the progress made in bus design and construction, with special reference to the chassis, states that refinements rather than radical developments have been the order of the past 12 months. It is stated that the greatest development, as measured in number of new models offered, has been in the large single-deck buses, known as the heavy-duty type. Other improvements that are mentioned include progress in generator equipment, the growth of power-applied brakes, the increased use of aluminum disc wheels and the application of auxiliary mechanisms to secure easy riding.

UNIVERSAL MOTOR-CAR ENGINE STAND. Published in *Engineering*, Dec. 28, 1923, p. 815.

A stand is described which has been designed and constructed to meet the need, in many classes of work in the assembly and repair of motor-car engines, for a device that will make it possible to tilt the engine to a greater or less extent and keep it in that position until the particular work

(*Continued on p.* 16)

We take pleasure in announcing
to
The Society of Automotive Engineers
that
after several years devoted to an intensive study of

Crankcase Contamination and Dilution

this Corporation is now prepared to place at the service of the Automotive Industry the knowledge gained from our research work.

We are offering in a commercial way, to the Engineers and Builders of Internal Combustion Engines' a comprehensive line of devices that have been designed to correct the varying conditions of Contamination and Dilution, as developed in the Crankcases of all types of Motors.

MOTOR IMPROVEMENTS, INCORPORATED
GENERAL OFFICES - FISK BUILDING
NEW YORK

Deppé Motors Corporation Superheated Gas System

(Patented)

This system in cars of the 3000 lb. class with engine displacement of 250 cubic inches gives results as follows:

With 100 lb. Compression

Fixed Superheated Gas Mixture

Fixed Adjustments in All Parts with Controlled Combustion

Develop maximum speed of 60 M.P.H.

Twenty-two miles per gallon with existing or any future motor fuels.

Sixteen hundred miles per gallon of lubricant.

Ten to 30 M.P.H. in 9 seconds.

Radiator water normally around 130° F.

NO THERMOSTATS

Easy starting, no loading.

Practically eliminates carbonization.

No preignition, no autoignition.

No so-called detonations.

Eliminates vibration due to fuel conditions.

Practically eliminates lubricating oil dilution.

No overheating of metals.

Practically eliminates valve grinding.

Practically eliminates bearing adjustments.

Practically eliminates spark-plug troubles.

PRACTICALLY ELIMINATES GEAR SHIFTING.

Deppé Motors Corporation

151 Church Street

New York City

NOTES AND REVIEWS

Continued

on it is completed. The stand is made in two sizes, the one suitable for all engines used on motor vehicles of sizes up to 5-tons and the other for heavy service.

CONVEYOR SYSTEM IN CONTINUOUS MOTION. Published in *The Iron Age*, Dec. 13, 1923, p. 1594.

This paper contains a description of a chain conveyor system for handling frames of automobile windshields during the enameling, baking and other operations. Features of this conveyor are its length, which is 1300 ft., and the numerous turns it makes in its winding course through the enameling department. Four illustrations accompany the description.

SALVAGING SCRAP IN CADILLAC PLANT. Published in *The Iron Age*, Dec. 13, 1923, p. 1571.

It is pointed out that the erection of a separate building, specifically designed for scrap handling, is a step toward more economic production, in that scrap, instead of being allowed to accumulate in the manufacturing departments, releases valuable space in the manufacturing building for production work. Such a building is described, and the various operations of scrap-salvage are told in some detail. The article is accompanied by five illustrations, including a reproduction of a scrap transfer form that is filled out by the inspector when material is ordered to the scrap department. This form is filled out in quadruplicate, one copy going to the planning department, another to the accounting department, a third to the scrap-salvage department, the fourth being retained by the inspector. Information on this form includes the department from which the scrap came, the part name and its number, the quantity, the nature of the defect, the kind of material and the number of operations performed on the piece before it was scrapped.

HOW TO SELECT A SPRING MATERIAL. By Joseph Kaye Wood. Published in *American Machinist*, Jan. 10, 1924, p. 49.

The author explains the quantitative method developed by him for determining a proper spring material. A chart is given which shows the relation between the load-deflection rate and the maximum safe range of deflection and a table gives the values of the material index and other properties for 17 metals. The question of the effect of temperature on the modulus of elasticity is discussed.

RUBBER SHOCK INSULATORS ON TAXICABS AND MOTOR CARS. Published in *India Rubber World*, January, 1924, p. 225.

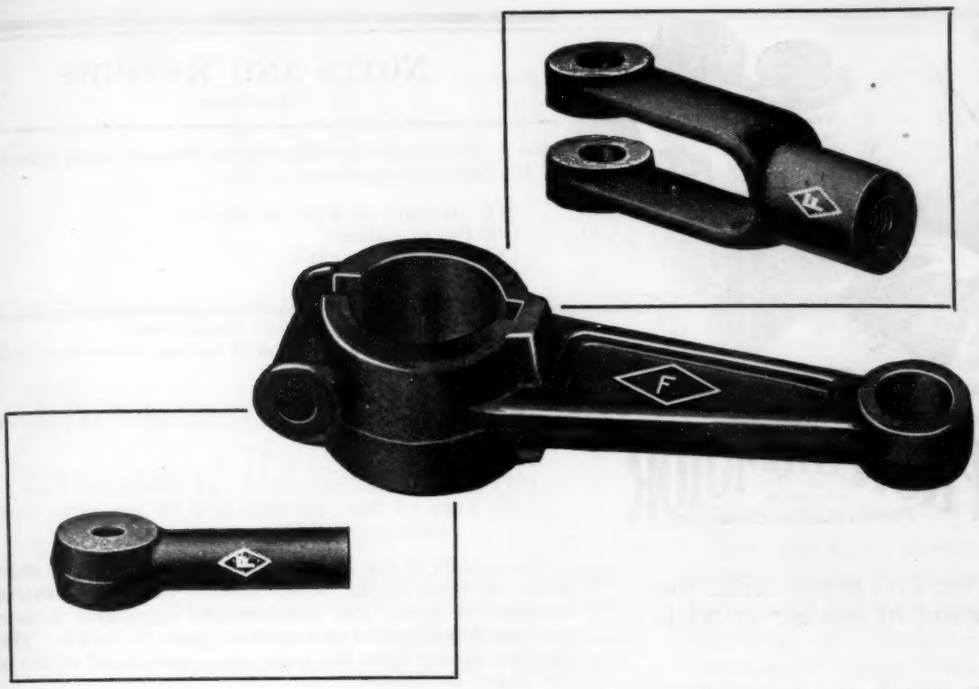
In a summary of the advantages of rubber shock insulators, the claim is made that a 50-per cent saving in tire mileage is expected because the rubber blocks absorb shocks and cushion jars and jolts, and that reduced gasoline consumption is effected because a car can be operated at a more uniform speed. Directions are given for applying shock insulators to existing cars. Further, it is stated that the insulators have been successfully applied in several other locations on motor vehicles, notably in torque rods and engine mountings.

EXHAUST-VALVE AND CYLINDER-HEAD TEMPERATURES IN HIGH-SPEED GASOLINE ENGINES. By A. H. Gibson and H. Wright Baker. Published in *Engineering*, Dec. 21, 1923, p. 785 and Dec. 28, 1923, p. 816.

The data contained in this paper are based on a number of tests, some of which were carried out on the cylinders of aeronautic-engines at the Royal Aircraft Establishment, others on a single-cylinder water-cooled unit; these two series were supplemented by a series of measurements made on aeronautic-engine cylinders fitted with water-cooled exhaust-valves.

It is stated that the tests were designed with a primary

(*Continued on p.* 20)



Old line—

New Trade-Mark— Service better than ever!

Pat. Nov. 15, 1921

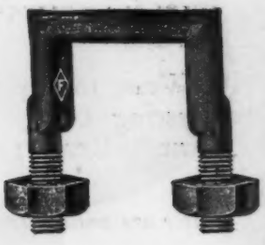
Our specialization in Yoke Ends Brake Rod Assemblies, Spring Clips, Shackle Links, Levers and the Gemmer Brake Rod Adjuster enables us to offer the highest quality Drop Forgings at the lowest competitive prices.

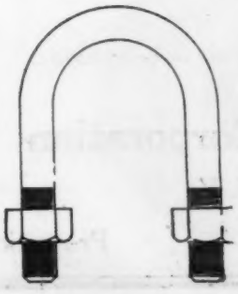
We are the sole manufacturers of the Gemmer Brake Rod Adjuster, **the keystone of equalized brake adjustment,** now used as standard equipment by more than 75 makers of automotive vehicles.

Pat. Aug. 14, 1923

It does away with, and saves the cost of, turnbuckles, adjustable yokes, lock-nuts, cutting and threading of rods. Just turn the thumb screw to take up the wear. **It locks automatically.**

Quotations cheerfully furnished.





Keystone Forging Co.

Consolidated with M. J. Ford Mfg. Co.
Plant—Northumberland, Pa.

New York Office—347 Fifth Avenue

Detroit Office—General Motors Bldg.
San Francisco—Mills Bldg.

The ONLY device that filters ALL the dust, sand and grit out of the air at ALL speeds.

This is our claim which any automotive engineer can demonstrate to his own satisfaction by comparative tests.

Alexander Johnston, Editor of "Motor," says:

"So far as my experiments have gone, I have found only one cleaner, a filtering type, The Protectomotor, that really shows no power loss or otherwise changes the performance of the engine, and it is practically 100 per cent efficient.

"In the tractor field three types of cleaners are in use, the water type, centrifugal, and the filtering. The water type is out of the question since it restricts the power output. It is large in size and cannot be used in cold weather on account of freezing. The centrifugal is not only restrictive in power, but permits some dust and dirt to pass through, especially the fine grit which is most destructive. The filtering type can easily be tested by throwing into it a handful of dirt. It will catch all, while the average centrifugal will permit a good quantity to pass through."

We would be glad to send a Protectomotor to the engineering department of any automobile, truck or tractor manufacturer for purposes of making tests to verify our claims.

Write to-day for our booklet, "An Interesting Case, Protectomotor vs. Road Dust." Read it and act as judge and jury.

We are willing to leave the case in your hands.

Staynew Filter Corporation

Rochester, N. Y.

Perfect, Positive, Protection

NOTES AND REVIEWS

Continued

view to determine the effect on the exhaust-valve temperature of the following variables:

(1) Strength of working mixture
(2) Power output
(3) Compression-ratio
(4) Speed
(5) Spark-advance
(6) Cylinder-jacket-water temperature
(7) Position of admission of cooling water to cylinder-jacket
(8) Shape of valve
(9) Width of valve-seat; cooling effect of valve-seat and guide
(10) Lift of valve
(11) Valve tappet clearance
(12) Type of fuel, gasoline and 20 per cent benzol-gasoline mixture

The details of the cylinders tested are tabulated under the heads of bore, stroke, type, number of exhaust-valves and diameter in port. The experimental apparatus is described and the procedure of the tests is given in detail. The conclusions drawn from the tests are summarized at the end of the paper as follows:

The investigation goes to show that, in a well-designed and well-cooled overhead-valve gasoline-engine, either of the air-cooled or water-cooled type, under normal conditions of operation the temperature of the exhaust-valve may be between 600 and 750 deg. cent. (1112 and 1382 deg. fahr.). The temperature is affected by a large number of factors, the most important, in an engine operating without detonation, being the timing of the ignition, the temperature of the cooling water and the strength of the working mixture. The highest temperatures under such conditions are attained at full throttle with the weakest mixture capable of maintaining the maximum load, with the highest jacket-water temperatures and with a retarded ignition.

In a given cylinder, with different compression-ratios, the exhaust-valve temperature at any given horsepower within the capacity of the cylinder having the lowest compression-ratio, is sensibly independent of the compression-ratio.

If, owing to some such hot-spot in a cylinder as may be produced by the action of a loose valve-seat or of a defective spark-plug, preignition is set up, the temperature of an exhaust-valve may readily attain temperatures exceeding 800 deg. cent. (1472 deg. fahr.). At such temperatures the valve, whether of chromium or tungsten steel, will burn out rapidly. At lower temperatures chromium steel has the advantage of not oxidizing so rapidly as tungsten steel with weak mixtures, although at temperatures not exceeding 750 deg. cent. (1382 deg. fahr.) both are capable of giving excellent results.

The best shape of valve-head appears to be one having a flat bottom and a tulip-shaped top. Owing to the weight, this is in general impracticable, and the next best is one having the tulip-shaped head common in aeronautic-engine practice. Increasing the lift of the valve within limits tends to cool operation by reducing the mean scouring velocity of the gases.

Within the limits usual in practice, tappet clearance does not greatly affect valve temperatures. Even negative clearance, so long as this does not exceed about 0.01 in., has only a small effect.

Generally speaking, the conditions tending to give a hot valve also tend to give a hot cylinder-head. The result of retarding the ignition is exceptional in that it gives a hot valve but a cool head. The range in

(*Continued on p.* 22)

BUFFALO

WIRE *Wheels* DISC

The sensation of the automobile industry

It's the sensation of the National Shows—the revolutionary principle represented by the BUFFALO small diameter wheel and the "balloon" tire.

No matter what the make or the price of your car may be, BUFFALO Wheels and "balloon" tires will make it a BETTER car—a car that rides easier, drives easier and operates with greater economy.

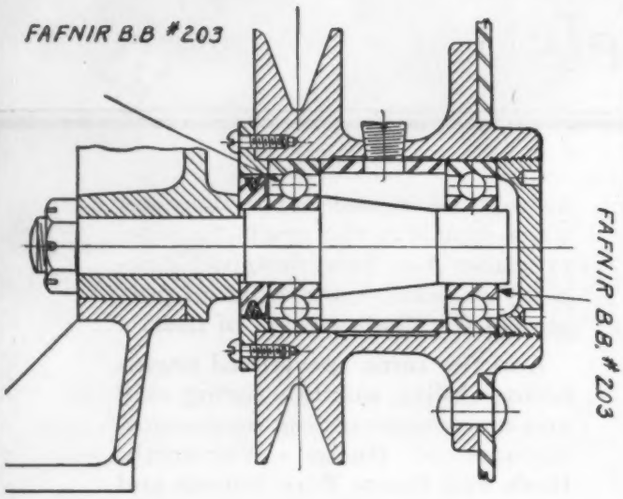
BUFFALO Wheels, either Wire or Disc, are available in standard sizes as well as in the small diameter sizes—but it is the small diameter type that has been designed especially to achieve the original purpose of the "ballooning" of tires.

And the same specialized engineering ability, manufacturing skill and many outstanding mechanical features of Rudge - Whitworth, Houk and House Wire Wheels and BUFFALO Disc Wheels that have led to their adoption as standard equipment on the world's finest cars are embodied in wheels bearing the BUFFALO symbol of superiority.

WIRE WHEEL CORPORATION
of AMERICA
Buffalo, N. Y.

for "balloon" tires

FAFNIR



An Automobile Fan Mounting

A feature of this mounting is the way in which the **Fafnir Ball Bearings** are installed in the fan hub. The most obvious way of doing this would be to fit the bearings in pockets counter-bored in both ends of the hub. In order to avoid the cost of extra machining, however, the ball bearings are here shown installed between end caps and a spacing member.

We would also call attention to the fact that, as in this instance, it is the housing which revolves; it is advisable to reverse the usual procedure and install the bearings with light press fits in the hub and sucking fits on the shaft.

Fafnir Ball Bearings in all standard types and sizes are manufactured with the utmost accuracy from thoroughly heat treated chrome alloy steel.

Realizing that readers of this magazine are chiefly technical men, we will occasionally use in our advertisements examples of typical automotive mountings.

THE FAFNIR BEARING COMPANY

New Britain, Conn.

CHICAGO, ILL.
537 South Dearborn St.

DETROIT, MICH.
120 Madison Ave.
Room 511

CLEVELAND, OHIO
1016-1017 Swetland Bldg.

NEW YORK, N. Y.
5 Columbus Circle

NEWARK, N. J.
271 Central Ave.

PHILADELPHIA, PA.
1427 Fairmont Ave.

NOTES AND REVIEWS

Continued

the cylinder-head temperatures corresponding to a given change in the operating conditions is, however, much smaller than the range of temperatures of the exhaust-valve.

Valve temperatures are sensibly the same whether gasoline or a gasoline-benzol mixture is used as a fuel. In this connection benzol is only of real advantage under conditions in which the use of gasoline would be accompanied by serious detonation leading to pre-ignition.

By water-cooling exhaust-valves the temperature can be reduced to about 300 deg. cent. (572 deg. fahr.) and such valves enable the output and the efficiency of an engine to be appreciably increased. They also enable a higher compression ratio to be used. They are, however, only suitable for use on an air-cooled engine, and if water is used as the cooling fluid, unless carefully designed, are likely to prove a source of danger.

NON-FREEZE SOLUTIONS FOR THE RADIATOR. Published in *Motor Transport*, Dec. 1, 1923, p. 304.

A brief treatment of the common difficulties experienced with alcohol and glycerine solutions and suggested remedies. One feature of the paper is the inclusion of five tables of non-freezing solutions. These tables show the percentage of each substance entering into a given solution, together with the freezing point and the boiling point of the solution thus formed.

USE OF ALUMINUM TO PREVENT STEEL CORROSION. By Arthur V. Farr. Published in *Chemical and Metallurgical Engineering*, Dec. 31, 1923, p. 1188.

A description of the calorizing process that consists in alloying the surface of steel with aluminum. It is claimed that calorized steel tubes have all the advantages of the structural strength of steel tubes together with the corrosion resistance of aluminum.

THE DEVELOPMENT OF MODERN STAMPING PRACTICE. By W. W. Galbreath and John R. Winter. Published in *Mechanical Engineering*, January, 1924, p. 17.

The history of the use of pressed metal is outlined, with special reference to the automotive field. Although it is admitted that it is not the aim of the pressed-metal manufacturer to eliminate castings, inasmuch as there are thousands of parts that are cast which cannot be produced in any other way, yet it is claimed that pressed metal is making a wonderful contribution to industry in speeding up the production of parts, reducing excessive unnecessary weight, eliminating many expensive machining operations and saving material and handling costs, in addition to savings in plant investment that would have to be made to take care of the many finishing operations required when cast parts are used.

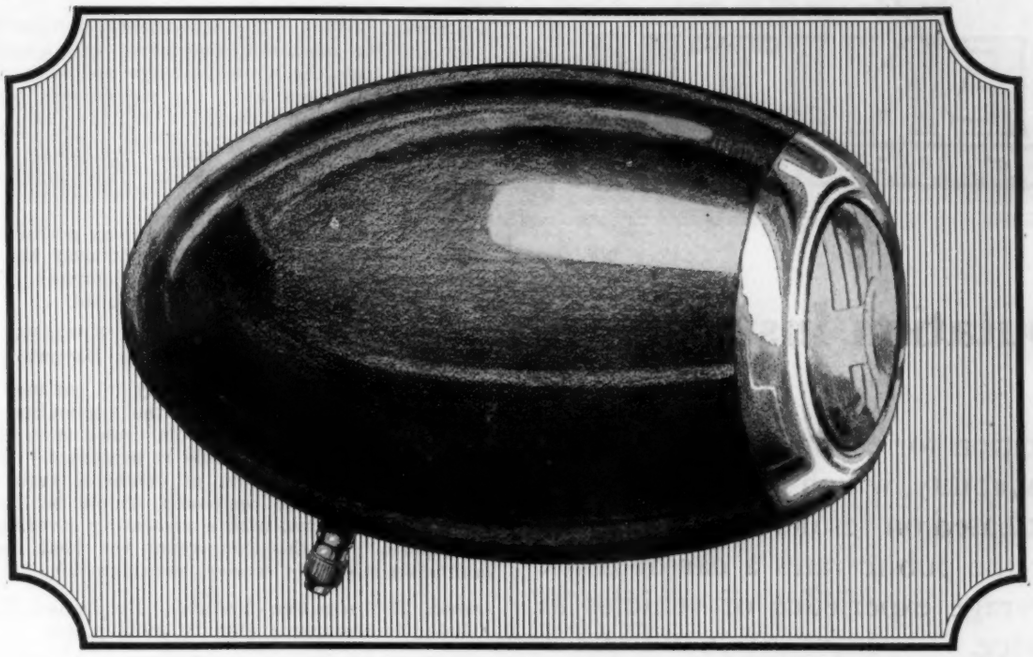
MODERN PISTON-RING PRACTICE INVOLVES EFFICIENT DESIGN AND PRODUCTION. By P. M. Heldt. Published in *Automotive Industries*, Dec. 13, 1923, p. 1204.

In this article the author concludes his discussion of modern piston-ring practice with a treatment of ring materials, individual versus pot castings, oil wiper rings and testing methods. Various testing devices are described and are illustrated by diagrams.

MACHINING HUDSON SUPER-SIX LYNITE PISTONS. By Charles O. Herb. Published in *Machinery*, January, 1924, p. 365. 16 illustrations.

After a brief mention of the advantages and disadvantages of aluminum pistons, attention is called to an aluminum-alloy piston that has been developed, known as a constant-clearance piston, and the claim is made that it overcomes certain of the difficulties believed to be inherent in ordinary

(*Continued on p.* 24)



EDMUNDS & JONES ANNOUNCE

THE E & J TYPE 20 HEADLIGHT

An Entirely New Principle in Automotive Headlight Equipment

The E & J Type 20 Headlight is as radical a change in automobile headlight equipment as was electricity when it replaced acetylene gas. Its scientific construction at last *provides ideal road illumination.*

By the skillful combination of an ingenious reflector and amber screen in the E & J Type 20 Headlight, light rays are projected through a double convex lens casting a strong, white light for a distance of 500 feet, but approaching motorists see only a soft, amber glow. *This eliminates dimming.*

The E & J Type 20 Headlight is a complete lighting unit and as such the height, strength and distance of light rays, projected by it, can be aimed and focused to conform with any lighting regulations. *Therefore, it meets the law in every state.*

This lamp represents the accumulated experience of twenty years devoted to the manufacture of lighting equipment for motor cars. It is a fitting achievement on the twentieth anniversary of its perfectors, *in honor of which occasion it is named.*

(*Manufactured under Bone Patent, August* 30, 1921, *other Patents Pending*)

EDMUNDS & JONES CORPORATION
DETROIT, MICHIGAN
"The Safest Light in Motordom"

ZENITH
CARBURETOR

Reputation Insurance

The reputation for economy, performance and dependability, which your product enjoys is not based on results attained in factory tests; the public rates a car or truck on the average experience of vehicles in actual service.

Zenith fixed adjustment makes certain the standards you set will be met by the user; for the correct adjustment of the carburetor—the greatest factor in economy—is not easily upset by driver or mechanic.

Over 160 American manufacturers are now stabilizing performance and insuring reputation through equipping with Zenith Carburetors.

Our engineers will gladly cooperate with you, to determine exactly what Zenith can do for you.

ZENITH-DETROIT CORPORATION
Manufacturer of
ZENITH CARBURETORS
DETROIT MICHIGAN
Branches:
NEW YORK · CLEVELAND · CHICAGO
Service Stations in over 800 cities

NOTES AND REVIEWS
Continued

aluminum pistons. The equipment employed in its production and the machining operations are described in detail, from the time the lynite castings are delivered to the machining department until the pistons are conveyed to the assembling department.

PISTON PINS AND END PLUGS. By Fred H. Colvin. Published in *American Machinist*, Dec. 20, 1923, p. 912. 2 illustrations.

Details are given of the operations performed in making piston pins and the plugs that fit over the ends for the engines used by an aeronautical company. The questions of tolerances and hardness are included.

PISTON INSULATION IN LARGE OIL ENGINES. By M. Candelero. Published in *Motor Ship*, December, 1923, p. 326.

A discussion of the possibility of cutting the heat loss entailed by piston cooling by the application of insulating material in front of the piston crown instead of water or oil circulation on the outside is presented. The suggestion is made that a stratum of cohibent, such as laminated asbestos or graphite compound, should be located in front of the piston crown, with a protecting covering of wrought-iron plate. In this connection the heat conductivity of laminated materials receives consideration.

DIESEL ENGINES FOR YACHTS. By Daniel H. Cox. Published in *Motorboat*, Dec. 10, 1923, p. 18.

Calling attention to the fact that recently internal-combustion engines that use heavy oil for fuel have been to some extent superseding steam as the motive power for yachts, this article sums up the principal arguments for and against the use of Diesel engines as compared with steam engines and also as compared with gasoline engines.

A comparison is made between a sea-going Diesel yacht and a steam yacht of similar dimensions and a like comparison is made in the case of coastwise vessels. From these comparisons the conclusion is drawn that if Diesel engines are used in place of steam, the vessel's dimensions being the same, an owner can secure at a slight increase in the first cost much more accommodation, equal speed and many times the cruising radius possible with steam, while the crew will be less and all operating costs will be greatly reduced.

HAND TACHOGRAPH AND SPEED INDICATOR. Published in *Engineering*, Dec. 21, 1923, p. 773.

The hand tachograph, illustrated and described in this article, weighs 2¼ lb. complete and can be used to obtain a clear record of the speed fluctuations of a machine over a wide range, as well as to determine the rate of acceleration or deceleration after the driving power has been applied or cut off. It is described as follows:

> The tachometer mechanism is of the ordinary type and needs no description, but the reciprocating spindle that operates the hand is extended out through the metal case of the tachometer and connected with a series of multiplying levers to operate the recording pen. A roll of paper, about 2¾ in. wide, is carried on a movable holder and fed through the instrument by a watch mechanism. The paper is driven by a knurled roller against which it is pressed by a spindle carrying a number of sharp-edged discs that also bear on an inked roller so that they mark the abscissas on the paper as it travels through. The spacing of the discs, of course, corresponds with the main divisions on the dial of the indicator. The watch mechanism driving the paper will run for 30 min. and is wound up by the larger of two knurled knobs. Two paper speeds are provided, the movement being about 3 or 6 mm. per sec. (0.11811 or 0.23622 in. per sec.) respec-

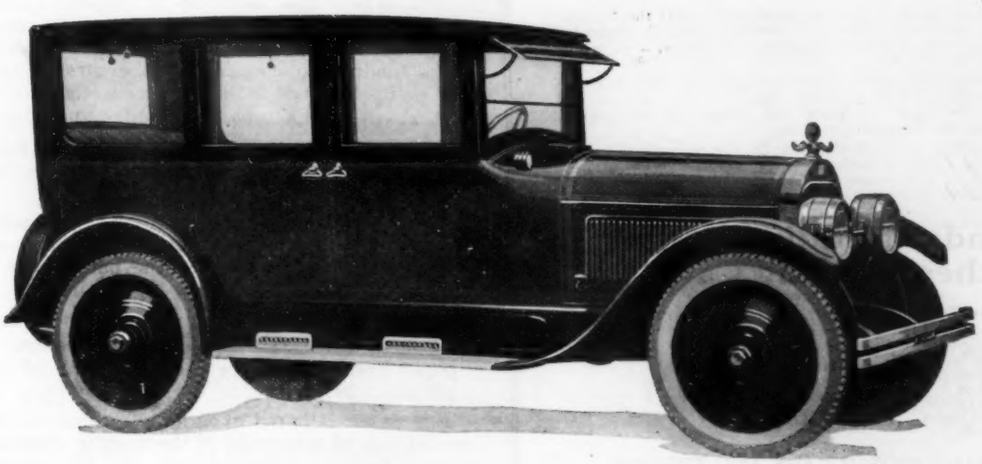
(*Continued on p. 26*)

DéJon

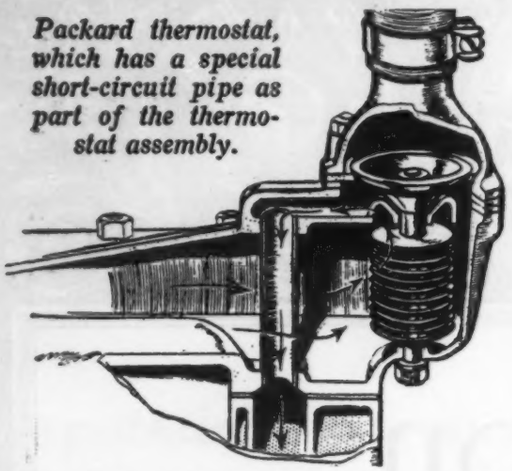
Starting, Lighting and Ignition System

DÉJON was inspired by a demand from a preferred list of car builders seeking the Electrical System of finest quality. Conclusive evidence that *DéJon* equipment endows a car with a proficiency beyond comparison is found in the new FLINT.

DéJON ELECTRIC CORPORATION
Builders Ignition Technique
POUGHKEEPSIE, NEW YORK



The FLINT *Six*



Packard thermostat, which has a special short-circuit pipe as part of the thermostat assembly.

Standard Equipment on the "Packard", too!

The illustration shows a Sylphon Automobile Temperature Regulator installed on the famous Packard. This car carries it as standard equipment.

Controlling the temperature of the cooling medium, it greatly reduces the wear of valves, pistons and cylinders. Reduces crank case dilution and carbon deposits to a minimum and saves from 15 to 20% in gasoline consumption.

Automobile Temperature Regulator

Simple, self-contained, it has but three main parts: the Sylphon Bellows—that seamless, solderless, flexible all-metal expansion member, which is the heart of all Sylphon products; a valve and a housing for the Sylphon.

The Sylphon is filled with a highly volatile liquid, which vaporizes at a predetermined temperature, expanding the Sylphon and opening the valve to admit water and contracting and closing the valve when the temperature falls.

Is self-regulating, adapted to pump or thermo-syphon cooling systems, can be installed between the radiator and the engine, either in outlet or inlet water connection. Has no moving parts to wear out, needs no oiling and will outlast the motor.

Standard Equipment on these leading Cars

American Cars	Foreign Cars
Cadillac	Fiat
Cunningham	Lanchester
Lafayette	Leland
Lincoln	Napier
Packard	Rolls-Royce
Paige-Detroit	Straker-Squires
Pierce-Arrow	Vauxhall
Premier	

AND MANY OTHER CARS AND TRUCKS

Do not accept imitations or substitutes. We are the originators, patentees and sole manufacturers of Sylphon Regulators.

Send for Bulletin JUR

THE FULTON COMPANY
KNOXVILLE, TENNESSEE
New York Chicago Detroit Boston Philadelphia
Representatives in all Principal Cities

NOTES AND REVIEWS

Continued

tively, and the change from one speed to the other is effected by a small lever at the top of the box containing the watch mechanism.

The time is recorded by a second watch mechanism enclosed in the same box as the paper-driving mechanism and wound up by the smaller of two knurled knobs; both mechanisms are, of course, non-magnetic. The time-recording mechanism, which is completely independent of the paper-driving mechanism so that it is not affected by any variations in the resistance of the latter, operates a small pen that bears on the paper and marks a continuous line with a slight kink at intervals of every second, or it can be arranged to mark intervals of 0.2 sec. if preferred. In either case, the time-marking appears at the top of the record, so that the rate of the speed fluctuations or the change of speed in any given time can easily be determined.

These instruments can be supplied for any speed-range between 30 and 24,000 r.p.m., but are only stocked for the ranges of from 30 to 4000 r.p.m. and from 60 to 8000 r.p.m. In either case, the range is covered in four stages, the change from one range to the other being effected by a sliding button on the casing near the spindle, as is usual in this class of instrument. The recording device can, of course, be used over the whole speed range, the change from one stage to the other being effected by the operator, who moves the sliding button as the pen approaches one edge or the other of the paper strip. The fact that a change in the scale has been made in the course of a record is indicated by the rapid movement of the pen across the whole width of the paper. The instruments are supplied with a set of steel and rubber points for connecting the spindle to any form of shaft center, and also with a rubber-edged disc wheel that can be used to record surface speeds and to determine the speed of shafts of which the ends are inaccessible. The disc wheels are supplied either 6 in. or 10 cm. (3.937 in.) in circumference.

The article also describes a speed indicator that is said to have been "designed to enable the average speed of a shaft to be determined rapidly and accurately, its arrangement tending to eliminate the errors of observation that can easily be made in measurements of this kind as usually carried out with a separate counter and stop-watch."

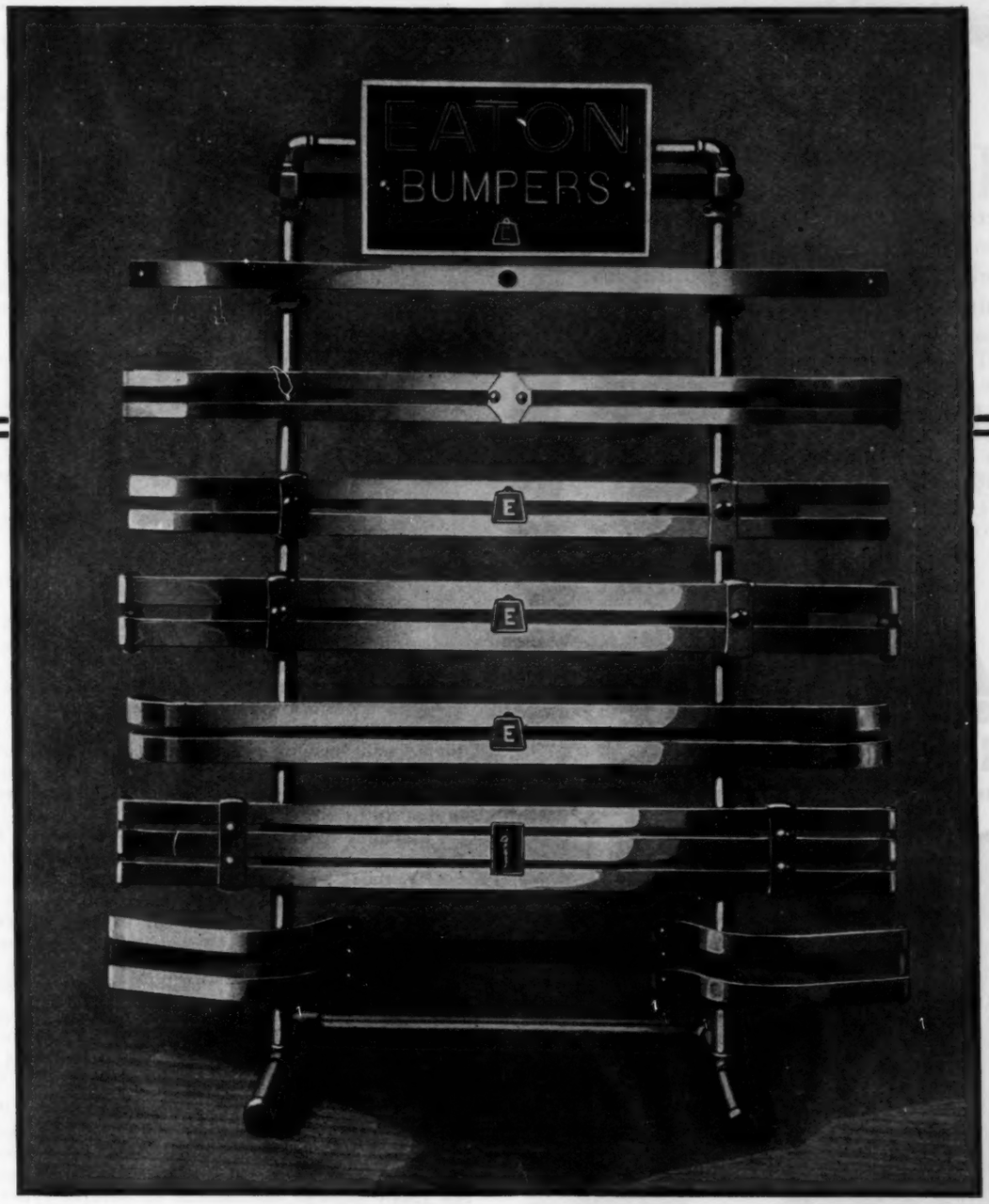
THE PAD SYSTEM APPLIED TO JOURNAL BEARINGS. By Major Johnstone-Taylor. Published in *American Machinist*, Jan. 3, 1924, p. 9. 4 illustrations.

The lubrication of a journal bearing equipped with pads is contrasted with that of an ordinary journal bearing, the conclusion being drawn that the pad system results in the more scientific application of lubrication.

SOME EXPERIMENTS IN THE LUBRICATION OF COMMERCIAL-VEHICLE ENGINES. By H. D. Nickinson. Reprint of a paper presented before the Institution of Automobile Engineers. 26 pp.

This paper is based upon some commercial tests that were carried out to ascertain if the results obtained when using various brands of lubricating oils for internal-combustion engines differ, and to see if, for commercial work, it is good policy to buy an expensive oil, or otherwise. Details are furnished concerning the engines and the seven oils used, the repairs made during the tests and the condition of the engines after the tests. Notes on the oil drawn from the crankcases after the tests include a consideration of fuel dilution and viscosity, flash-point, ash, acidity and carbonization. One conclusion that is drawn is that the flash-point of an oil is not much guide as to its lubricating qualities, and that there is no necessary relation between flash-point and volatility.

(*Continued on p.* 28)



CAR manufacturers will find it to their advantage to standardize on Eaton Bumpers. Would you like to know the reasons?

UNDERWRITERS LABORATORIES FOR PASSENGER AUTOMOBILES OF ALL WEIGHTS EATON AXLE & SPRING CO. CLEVELAND PATENTS PROTECTED INSPECTED BUMPER B-4

The EATON AXLE & SPRING COMPANY

CLEVELAND

EATON AXLES *PERFECTION SPRINGS* *EATON BUMPERS*

New York
1846 Broadway

Chicago
2637 S. Michigan Avenue

Philadelphia
223 N. 22nd Street

Boston
162 Brookline Ave.

Albany
N. Pearl & Van Woert Sts.

Cleveland
6515 Carnegie Ave.

Character

THE ability of an organization to answer its problems of adversity, to accept victory, to make competent judgment of the past and to prepare for the future, all enters into the structure of its character.

The products of an industry partake of the character, in kind, quality and design of the corporation that produces them.

Our successful growth is a tribute to the character and product of this organization.

You can use our product to good advantage.

The World's Largest Producers of Automobile Cushion Springs

LAYoung Industries Inc.

Detroit Michigan

NOTES AND REVIEWS

Continued

The results of this series of tests apparently indicate that the cheapest oil did the job as satisfactorily as the most expensive oil.

It is stated that these tests were run purely as commercial tests, no special precautions being taken with the engines except that they were so far as possible all alike as commercial units. They were operated as part of a commercial fleet and were subject to all the varying factors common to a fleet of vehicles. The paper contains 12 illustrations and 4 tables.

THE COMMERCIAL POSSIBILITIES OF THE AIRPLANE. By Archibald and Donald R. Black. Paper presented at the annual meeting of the American Society of Mechanical Engineers, Dec. 6, 1923.

The authors give estimates of the capital required for financing air lines and of the cost of their operation. The major divisions of these costs are shown and the conclusion drawn that the oil companies will probably gain more revenue from the development of commercial aviation than either the airplane or the engine builders.

Curves are presented showing the very rapid drop in operating costs with increased operations, and possible further increases are discussed. Drastic cuts in rates are shown to be possible upon the slightest increase in the operation of present lines.

Because of operating costs, the immediate field of the airplane is claimed to be that of carrying mail and packages rather than passengers, as the development of the latter traffic will have to wait until costs come down. Figures are given to show that a night air service could practically eliminate competing night-letter telegraph services for distances up to about 1200 miles.

Passenger fares are shown to be very high in small-scale operations, decreasing rapidly with increased operation to nearly those of the extra-fare trains. The conclusion is drawn that large-scale operations will bring the airplane into direct competition with the extra-fare train and that only lack of space for sleeping berths in airplanes can retard this competition. The suggestion is made that the railroads therefore investigate the possibilities of airplane operation.

THE SMALL ANGULAR OSCILLATIONS OF AIRPLANES IN STEADY FLIGHT. By F. H. Norton. National Advisory Committee for Aeronautics Report No. 174. Published by National Advisory Committee for Aeronautics, City of Washington. 8 pp.

The investigation reported in this paper was carried out by the National Advisory Committee for Aeronautics at the request of the Army Air Service to provide data concerning the small angular oscillations of several types of airplane in steady flight under various atmospheric conditions. The data are of use in the design of bomb sights and other aircraft instruments. The method used consisted in flying the airplane steadily in one direction for at least 1 min., while recording the angle of the airplane with the sun by a kymograph. The results show that the oscillations differ but little for airplanes of various types, but that the condition of the atmosphere is an important factor. The average angular excursion from the mean in smooth air is 0.8 deg. in pitch, 1.4 deg. in roll and 0.9 deg. in yaw, without special instruments to aid the pilot in holding steady conditions. In bumpy air the values given above are increased about 50 per cent.

A CONVENIENT FORMULA FOR ALTITUDE PERFORMANCE ESTIMATES. Published in *Flight*, Nov. 29, 1923, p. 729.

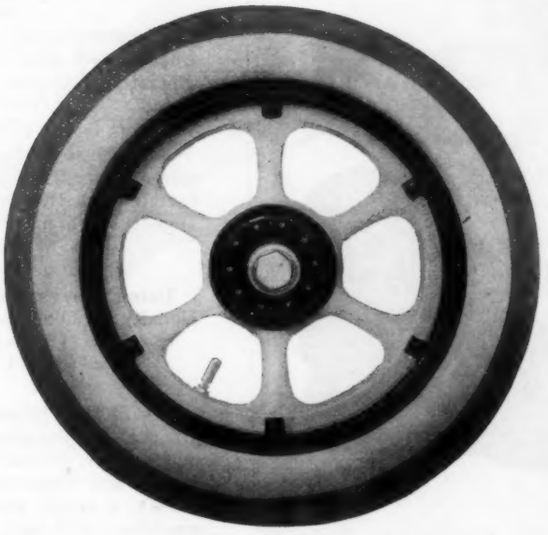
This brief article contains the following information:

W. S. Shackleton, designer of the A. N. E. C. light airplanes, has very kindly sent us the following density formula, which has been deduced by Professor

(*Continued on p.* 30)

A NEW TYPE OF WHEEL FOR PASSENGER CARS

Manufactured by
Smith Wheel, Inc.
SYRACUSE, N. Y.



Designers and Makers of Approximately 70% of All Metal Truck Wheels Used in America.

THE Smith Expanded Wheel is designed and made with the intention and result of eliminating every objectionable feature in other makes of wheels.

This new wheel weighs about the same as a wood wheel, is one piece construction of metal alloy most suitable to its service requirements, hollow throughout the entire structure of hub, spoke and felloe, with hub and felloe both containing numerous internal braces.

Its life is everlasting.

It is the most economical wheel in the saving of tire wear and consumption of gasoline because it takes the ground and leaves the ground round, as no other wheel does. There is no deflection in the felloe at the point nearest the ground at any time during its service life. It is machined round and true and always retains its true dimensions regardless of service conditions.

The open construction radiates the heat from the tires which increases the life of the tires.

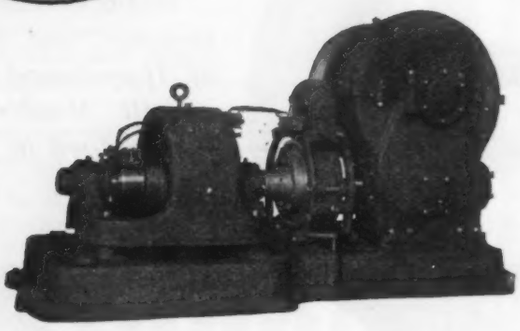
Many other interesting features.

We welcome requests for particulars.

SMITH WHEEL, Inc.

Syracuse, N. Y.

Shepard Elevator Engine



The Shepard Elevator Co. of Cincinnati have pursued a policy of consistent advance in the design of their machines.

When they put out a machine that is the best that years of designing and experience can produce they equip it throughout with Gurney Ball Bearings. Why? Because they have had years of experience with Gurney Ball Bearings.

Ask our Engineering Department to assist you.

GURNEY BALL BEARING CO.

402 Chandler St.

Jamestown, N. Y.

GURNEY BALL BEARINGS

NOTES AND REVIEWS

Continued

Knoller of the Technical University of Vienna, and which has not, as far as we are aware, been published, at any rate in this country. The formula has the merit of great simplicity, being:

Density at an altitude of H kilometers = $(20 - H) \div (20 + H)$

The simplicity of the Knoller formula may be better appreciated when it is remembered that the French official formula is

$$[(288 - 0.0065\,H) \div 288]^{4.256}$$

where H is the altitude in meters.

Nevertheless, the results given are in very close agreement with those obtained by the more complicated formula, as the following example will show:

Density at 5 m. $= (20 - 5) \div (20 + 5)$
$= 15/25$
$= 0.6$ of sea-level density

Using the French formula the calculation becomes:

Density at 5000 m.
$= ([288 - (0.0065 \times 500)] \div 288)^{4.256}$
$= (0.887)^{4.256}$
$= 0.601$

It will thus be seen that the accuracy appears to be all that is required for practical performance estimates. Mr. Shackleton informs us that very accurate results are obtained up to an altitude of 12 km. (7½ miles), a height that is well above the ceiling of most machines, although Sadi Lecointe has reached 11,145 m. (6.9 miles) on his Nieuport-Delage.

If it is desired to use British units, with the altitude expressed in feet, the Knoller formula becomes:

$$(65{,}616 - H) \div (65{,}616 + H)$$

For example, the density at 20,000 ft. is

$(65{,}616 - 20{,}000) \div (65{,}616 + 20{,}000) = 45{,}616 \div 85{,}616$
$= 0.533$ of the density at ground level.

Accompanying the article is an altitude-density chart, based upon the Knoller formula, from which densities can be read off directly up to an altitude of 40,000 ft.

AERONAUTICAL SCIENCE. By Ivor B. Hart and W. Laidler. Published by the American Branch of the Oxford University Press, New York City. 288 pp.; 213 illustrations.

According to statements in the preface, this book is for the benefit of young students who desire to make an elementary scientific survey of the subject without becoming involved in anything more intricate than elementary algebra and trigonometry.

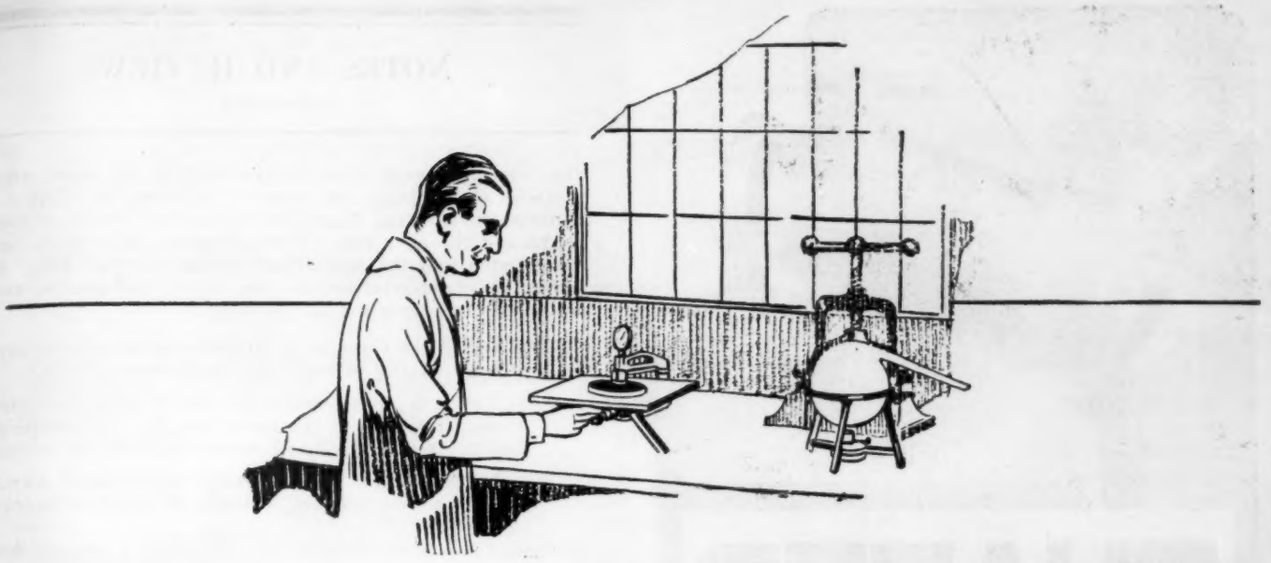
The introductory portion of the work is devoted to a historical statement together with a 27-page summary of facts and formulas of elementary mechanics, which summary may be omitted by students who already possess this knowledge.

Part II, on the Elementary Principles of Flight, contains chapters on the airfoil, the lift-drag ratio, stability, control and maneuver. Part III, which deals with the Structure of the Airplane, consists of chapters on the following topics: the airscrew; bending moments, shearing forces and stresses in beams and in airplane structures; materials used in the airplane; description of airplane parts; instruments; and the aircraft engine.

THE MANEUVERS OF INVERTED FLIGHT. By R. M. Hill. Published in the *Journal of the Royal Aeronautical Society*, December, 1923, p. 569.

The introduction includes a definition of inverted flight and reasons for an investigation of this nature. Topics

(*Concluded on p.* 32)



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FORMICA has established itself as the most uniform and dependable of silent timing gear materials—the product of an exactly controlled manufacturing process that assures unusual reliability.

A Formica laboratory has been established where the adaptation of Formica to specific motors is carefully developed by a recognized automotive engineer and the results turned over to the car or engine manufacturer.

Engineers are always free to call on the Formica Insulation Company for sample blanks and suggestions as to methods of cutting, mounting, the degree of backlash to allow—and other similar information which has been developed by long experience with the material, under a wide variety of conditions.

You are offered the most silent modern timing drive, retaining the positive timing of the gear system with freedom from the necessity of adjustment, —and exceptional durability and long life.

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FORMICA
Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS

SHAFER
Self-Aligning ROLLER BEARING
PAT. & PATS.PENDING
Shafer Bearings are self-aligning and automatically compensate for shaft deflections.
The concave rollers are set at an angle, and rotate between the convex cup and cone; absorbing thrust and radial loads from any angle applied.
SHAFER BEARING CORPORATION
6501 WEST GRAND AVENUE
CHICAGO, ILL.

NOTES AND REVIEWS

Concluded

that receive consideration in the body of the paper are the methods of attaining the inverted position, the effect of the controls in inverted flight, the method of resuming normal flight and the slow roll. Some attention is given to the inverted spin and the possibilities of the inverted loop. Conclusions are summarized at the end of the article, among which the following are outstanding:

On all the types of an airplane open to investigation, it was possible to maintain steady inverted flight.

There is no tendency for an unstable airplane to remain inverted in the sense that an experienced pilot has any real difficulty in recovering from the inversion.

In the design of a fighting single-seater airplane, specific account should be taken of inverted maneuver.

EXPERIMENTS WITH FABRICS FOR COVERING AIRPLANE WINGS TO DETERMINE EFFECT OF METHOD OF INSTALLATION. By A. Proll. From *Technische Berichte*, Vol. III, No. 6. National Advisory Committee for Aeronautics Technical Note No. 168. Published by the National Advisory Committee for Aeronautics, City of Washington. 48 pp.; 23 illustrations.

This report relates primarily to the effect of changes in the loading and in the disposition of the supporting framework, regarded as rigid, on the covering fabric. The tests took into consideration such topics as the effect of different arrangements of the supporting framework, non-uniform loading, different dispositions of the fabric and initially stretched fabric.

RELATIVE EFFICIENCY OF DIRECT AND GEARED DRIVE PROPELLERS. By Walter S. Diehl. National Advisory Committee for Aeronautics Report No. 178. Published by the National Advisory Committee for Aeronautics, City of Washington. 9 pp.

This report, which is an extension of the National Advisory Committee for Aeronautics Technical Report No. 168, has been prepared for the National Advisory Committee for Aeronautics to show the relative values of various direct and geared drives. It has been assumed that the speed V and the crankshaft revolutions are held constant at each value of $(V/ND)^2$ corresponding to the maximum efficiency for a two-bladed, direct-drive propeller, so that the corresponding (V/ND) and the maximum efficiency for any other propeller arrangement depends only on N and D, which are easily calculated. The net efficiencies are obtained by allowing 98 per cent for the gears and 95 per cent for the efficiency of a four-bladed propeller relative to a two-bladed propeller.

The net efficiencies so found are given in terms of the efficiency for the two-bladed, direct-drive case, and plotted against $(V/ND)^3$ so that having given the (V/ND) corresponding to the maximum efficiency for a two-bladed, direct-drive propeller, the relative gain or loss due to any ordinary arrangement may be readily estimated. The conclusion is reached that when $(V/ND)^3$ is greater than 0.70, gearing is not advisable.

METAL-CLAD VERSUS FABRIC-COVERED RIGID AIRSHIPS. By Ralph Upson. Published in *Aviation*, Dec. 10, 1923, p. 702.

With a view to increasing the commercial use of airships, the writer advocates the employment of sheet metal as the material for the envelope and claims that by changing the design so that the sheet metal of the envelope becomes part of the structure, instead of a mere cover, certain advantages will be gained, namely, increased fire-resisting quality, greater gas tightness, greater durability and reduced weight.

KERITE
A product of over fifty years distinguished service in the most important electrical fields, possessing inherent characteristics which make it pre-eminently desirable for High-Tension Automotive Ignition
DAYS KERITE
KERITE
INSULATED WIRE & CABLE
COMPANY
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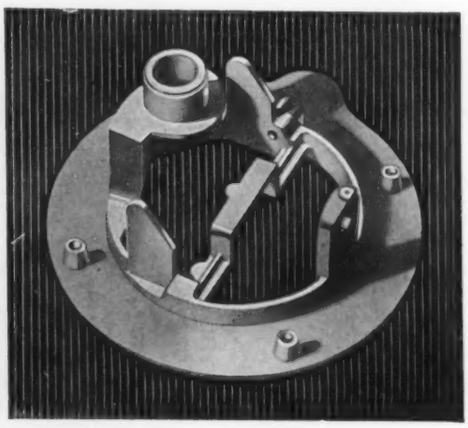
COMPANY

DOEHLER

The World's Largest Producer of

DIE-CASTINGS



The user of die-castings—in establishing his prices on his own product and in laying out his delivery schedules—can do so with confidence only when he has confidence in his source of supply.

In the matter of die-castings, the two complete Doehler plants—at Brooklyn and Toledo — give every Doehler customer a double protection against impairment either of quality or of delivery.

This is a form of "production insurance" which costs a Doehler customer nothing but which may save him thousands of dollars.

DOEHLER DIE-CASTING CO.
BROOKLYN, N.Y.
TOLEDO, OHIO.

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

Leclare H. Amrine has been appointed district sales manager for the Garford Motor Truck Co., Lima, Ohio. He was formerly assistant sales manager for the Dorris Motor Car Co., St. Louis.

Elmer H. Babel has joined the engineering department of the C. L. Best Tractor Co., San Leandro, Cal.

Howard G. Benedict, who was previously general manager of the A. J. Deer Co., Hornell, N. Y., is practicing consulting engineering in that city.

R. M. Bird resigned as engineer of tests at the Bethlehem, Pa., plant of the Bethlehem Steel Co., to become associated with George F. Pettinos, Philadelphia.

C. J. Bock is no longer automotive engineer for the Ordnance bureau at Rock Island Arsenal, Rock Island, Ill., but has joined the engineering department of the Yellow Coach Mfg. Co., Chicago.

A. Bondar has severed his connection with the Dayton-Wright Airplane Co., Dayton, Ohio, where he was aeronautical engineer. No announcement has been made of his plans for the future.

H. E. Borger has accepted a position as engineer for the Steiner Mfg. Co., St. Louis. He formerly held a similar position with the Durant Motors Co., New York City.

P. H. Brand, who was until recently chief engineer for the Little Giant Co., Mankato, Minn., has been appointed assistant mechanical engineer for Libby, McNeill & Libby, Chicago.

Arthur Brandes is now engineer for the T. E. Felt Motor Car Co., Los Angeles, Cal.

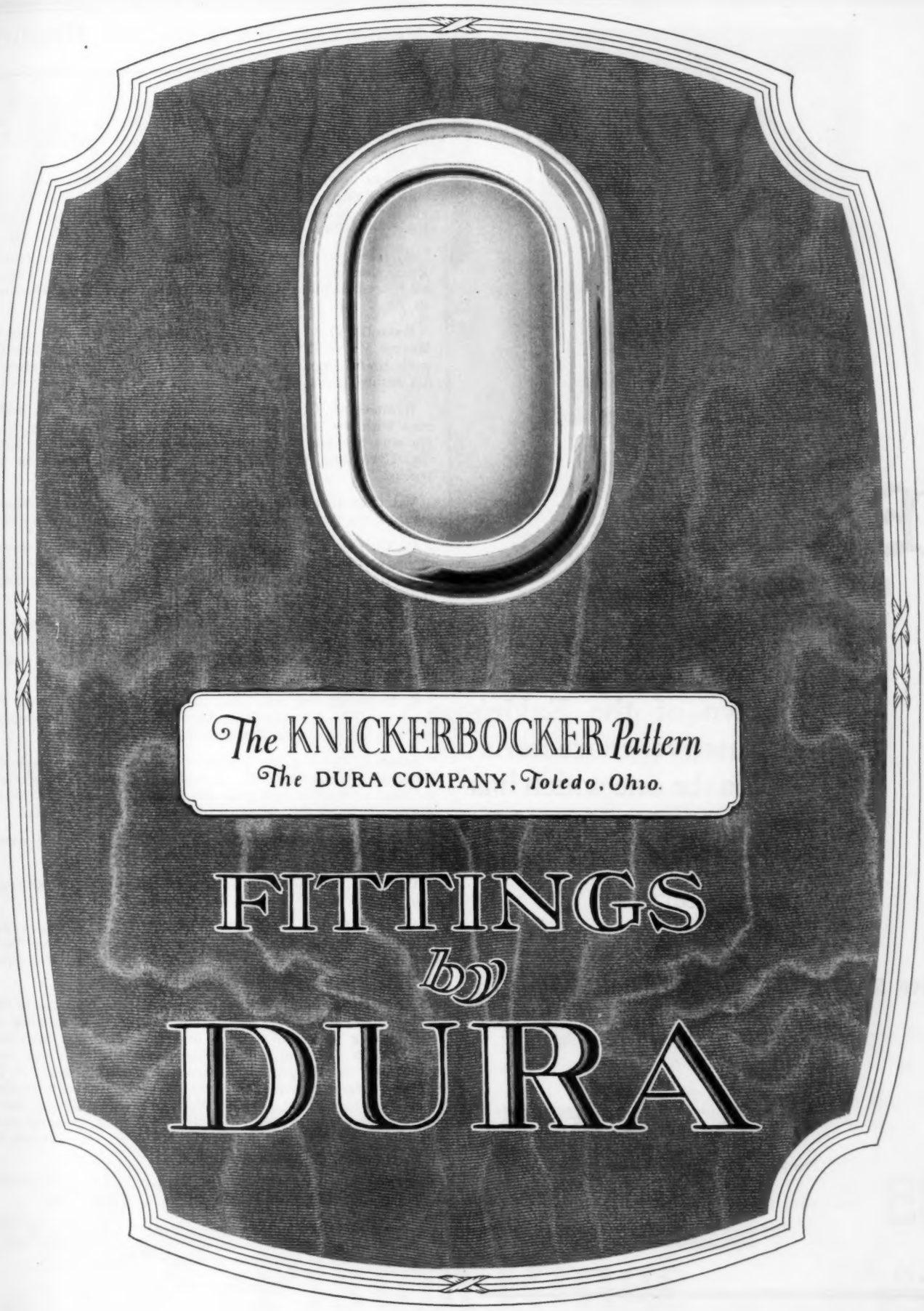
Harry C. Brokaw has become affiliated with the Buick Motor Co., New York City, in connection with retail sales. Previous to this he was director of technical schools at the West Side Y. M. C. A., New York City.

Harold Broock, who was until recently retail sales manager and assistant to the sales engineer for the Wilcke-Armstrong Co., Detroit, has been made assistant experimental engineer for the C. G. Spring Co. of Delaware, also of Detroit.

Oswald Cammann, Jr., has been appointed department head for the Riegel Sack Co., Jersey City, N. J. He was formerly engineer for the Davis Sewing Machine Co., Dayton, Ohio.

Robert Hall Campbell, who was until recently president of the Robert H. Campbell Co., Chicago, has become associated with the Frontenac Sales Co., Newark, N. J.

(*Continued on p. 4*)


The KNICKERBOCKER Pattern
The DURA COMPANY, Toledo, Ohio.
FITTINGS
by
DURA

Exide
BATTERIES

Probably the best known of the Exide's distinctive characteristics is the one which has led the motoring public to call it—"the long-life battery."

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA

The world's largest manufacturers of storage batteries for every purpose.

Branches in Principal Cities

In Canada, Exide Batteries of Canada, Ltd.,
133-157 Dufferin Street
Toronto

PERSONAL NOTES OF THE MEMBERS

Continued

Kenneth L. Childs is no longer engineer of research and development for the Standard Textile Products Co., New York City, but has become associated with the Fabric Body Corporation, Detroit, as president.

Mason S. Cooper has been elected president of the Associated Equipment Co., Inc., New York City. He was previously a salesman for the National Material Co., also of New York City.

Andrew L. Cormier, who was general mechanic with the Pennsylvania Railroad Co., at Columbus, Ohio, has resigned. His plans for the future have not been announced as yet.

Russell W. Cory, layout and design draftsman for the Master Motor Truck Co., Chicago, has severed his connection with that company. No announcement has been made of his future plans.

Kenneth G. Crawford has accepted a position as draftsman with the American Locomotive Co., Schenectady, N. Y. He was previously affiliated with the Sanford Motor Truck Co., Syracuse, N. Y., as layout draftsman, designing new trucks.

Val Cronstedt has joined the airplane engineering department of the Wright Aeronautical Corporation, Paterson, N. J.

C. C. Cross, who was formerly president and general manager of the Troy Body Co., Troy, Ohio, has been made general superintendent of the Fisher Body Corporation, Detroit.

P. J. Dasey, has been appointed sales engineer for the Wellman-Seaver-Morgan Co., Cleveland. Prior to this he was sales and research engineer for the Midwest Engine Co., Indianapolis.

R. E. Daugherty, who was until recently designer for the Goodyear Tire & Rubber Co., Akron, Ohio, has been appointed advisory engineer for Richards & Co., Findlay, Ohio.

James E. DeLong has become affiliated with the Waukesha Motor Co., Waukesha, Wis., as sales engineer. His previous business connection was with the Indiana Truck Corporation, Marion, Ind., in the capacity of general superintendent.

Charles de Lukacsevics is now chief engineer and owner of the C. de L. Engineering Works, Detroit.

Arthur H. Denison has accepted a position as chief engineer for the Weger Engine Co., Cleveland.

Edgar N. Dollin, who has been doing business in die-casting equipment and engineering at 6 Church Street, New York City, has been elected vice-president of the Allied Die-Casting Corporation, Long Island City, N. Y.

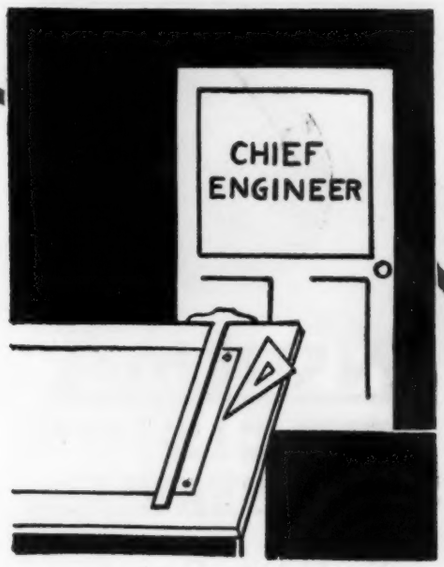
Harry S. Durland will in the future devote his time to the teaching of automotive engine repair and maintenance at the evening technical school division of Pratt Institute, Brooklyn, N. Y., and will be instructor of automobile mechanics at the Passaic Vocational Schools, Passaic, N. J. He was formerly associated with the editorial staff of *Bus Transportation,* New York City, and also the Wright Aeronautical Corporation, Paterson, N. J., and more recently with the inspection department of the Westinghouse Electric & Mfg. Co., Newark, N. J.

Ralph L. Evenburgh has accepted a position as chief draftsman for the Great Western Mfg. Co., La Porte, Ind.

C. C. Frame, who until recently was salesman for the White Truck Sales & Service Co., Detroit, is now chief engineer for the G. M. Diehl Machine Works, Wabash, Ind.

(*Continued on p.* 6)

Ask HIM



Ask any leading automotive engineer which piston ring is mostly used for initial installation and the prevalent answer will be **QUALITY**.

QUALITY Piston Rings are accurate, quick seating, long-lived, and easy to install and consequently have been adopted by the engineers of more than one hundred leading manufacturers of automobiles, trucks, and tractors.

The Piston Ring Company
Muskegon, Michigan

—built
"trail-
dustry"

QUALITY Piston Rings

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MICHIGAN PLANT
DETROIT

Exide
BATTERIES

Probably the best known of the Exide's distinctive characteristics is the one which has led the motoring public to call it—"the long-life battery."

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(*Continued on p.* 6)

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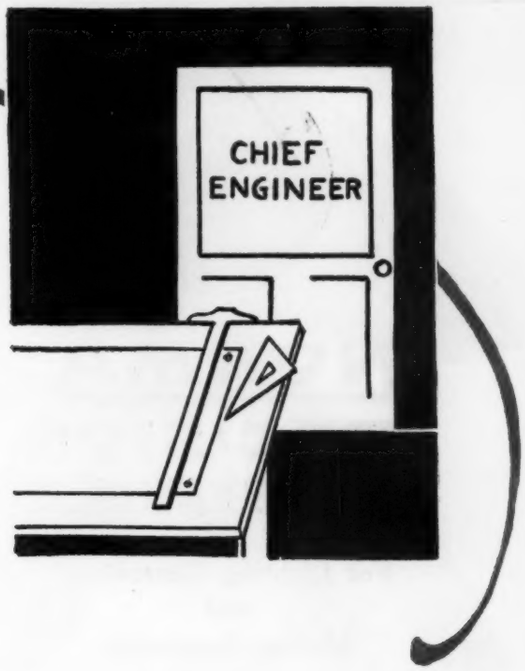

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QUALITY Piston Rings are accurate, quick seating, long-lived, and easy to install and consequently have been adopted by the engineers of more than one hundred leading manufacturers of automobiles, trucks, and tractors.

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QUALITY
Piston Rings

"NORMA"
PRECISION
BALL BEARINGS

For Lighting Generators
and
Ignition Apparatus

"There is no substitute for experience"—and no judgment is quite so apt to be sound as one arrived at by years of observation of results.

Today—after years of actual experience with "NORMA" Precision Bearings—the makers of most of the high-grade magnetos and lighting generators continue to use these high-duty, high-precision units.

Service records prove that magnetos and lighting generators with "NORMA" Precision Bearings run more quietly, last longer.

A booklet will be sent on request.
And our engineers will welcome
an opportunity to work with yours.

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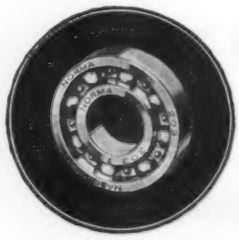
OF AMERICA
Anable Avenue
Long Island City New York
BALL, ROLLER AND THRUST BEARINGS



PERSONAL NOTES OF THE MEMBERS

Continued

George B. Gilbertson has received the appointment of midshipman at the United States Naval Academy, Annapolis, Md. He formerly attended the University of Minnesota, Minneapolis, Minn.

D. Gleisen has been made vice-president and treasurer of the Zimmerman Stove Heater Co., Inc., Kearny, N. J. Prior to this he was manager of the Eastern division of the Hyatt Roller Bearing Co., Harrison, N. J.

Phillip P. Glick, who was formerly chief inspector for the Moon Motor Car Co., St. Louis, has become affiliated with Victor Motors, Inc., also of St. Louis, as assistant to the chief engineer.

Fred C. Goldsmith is now superintendent of tools and equipment for the Chalmers Motor Corporation, Detroit. His previous business connection was with the Willys-Overland Co., Toledo, where he was engaged in production engineering work.

Samuel W. Gray has joined the engineering department of the Wheeler-Schebler Carbureter Co., Inc., Indianapolis. Until recently he was foundry superintendent of the Acme Works, also of Indianapolis.

Otis E. Griner has accepted a position with the Studebaker Corporation of America, South Bend, Ind. Prior to this he was assistant to the general manager in charge of sales and advertising for the Lubac Corporation, Chicago.

C. O. Guernsey has been appointed chief engineer of the automotive car division of the J. G. Brill Co., Philadelphia. He was previously general manager of the motorcoach division of the Service Motor Truck Co., Wabash, Ind.

W. F. Harrington has severed his connection with the American Swiss Magneto Co., Toledo, Ohio, where he was engineer. His future plans have not been announced.

G. D. Harris is no longer vice-president and general manager of the U. S. Tractor & Machinery Co., Chicago, but has become affiliated with the L. F. Kuehne Co., also of Chicago, as general executive.

Stanley D. Hartshorn has accepted a position with the Pennsylvania Crusher Co., Philadelphia. His previous business connection was with the International Motor Co., New Brunswick, N. J.

L. J. D. Healy has been made technical superintendent for the Federal division of the Fisk Rubber Co., Cudahy, Wis. He was formerly secretary and treasurer of the Wright Rubber Products Co., Racine, Wis.

H. C. Herbert, consulting engineer, Scarsdale, N. Y., has been appointed research engineer for the Locomobile Co. of America, Bridgeport, Conn.

Duncan C. Hooker has become affiliated with the Automatic Refrigerating Co., Hartford, Conn., and will be in charge of household refrigerator production.

George W. Jaggers is no longer mechanical draftsman for the J. L. Mott Iron Works, Trenton, N. J., but is associated with the Trenton Patent Mfg. Co., Inc., also of that city in a similar capacity.

Victor Jantsch has resigned as chief engineer of the Earl Motors, Inc., Jackson, Mich. His plans for the future have not been announced.

S. Kaplan has been appointed representative of the Metropolitan district for the Douglas-Dahlin Co., Kansas City, Mo.

(*Continued on p.* 8)

The name behind a valve

Automobile builders know the tremendous value of the name behind a car—

—more and more they are placing the proper value on the name behind a valve.

—built by a "trail-breaker of industry"

THOMPSON SILCROME VALVES

THE STEEL PRODUCTS COMPANY

MAIN PLANT
CLEVELAND

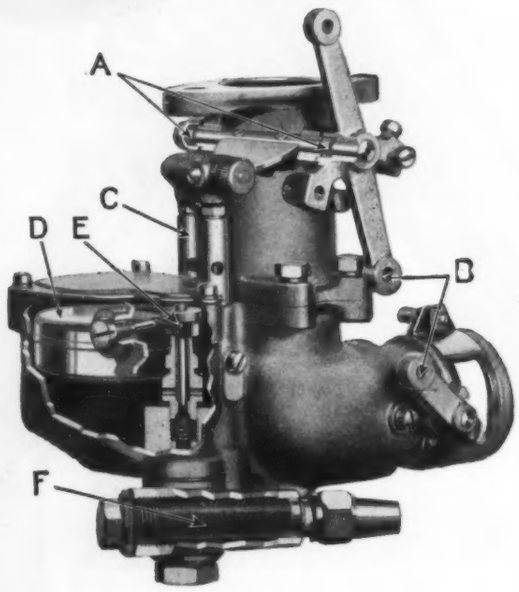
Also manufacturers of king bolts, shackle bolts, tie rod bolts, drag links, starting cranks, and brake rod assemblies

MICHIGAN PLANT
DETROIT

Specially Designed for Hardest Service

The New Model UF

ZENITH CARBURETOR



MANY refinements incorporated in this heavy duty Zenith bring to the operator of commercial automotive equipment freedom from trouble, minimized wear and dependability to a greater degree than was heretofore obtainable; yet it incorporates the "Power with Economy" which has made Zenith dominant in this field. To maximum economy of operation is added maximum economy of maintenance.

A. Easy starting and good idling—not only when new, but continuing indefinitely—is assured by eliminating throttle shaft wear by means of a ground steel shaft carried in renewable bronze bushings and protected from dirt by felt washers, held under compression.

B. Strength is increased by the use of heavier throttle and air shutter levers.

C. Starting is greatly facilitated by a special well providing a reserve of gasoline for this purpose.

D. "Spinning" of float and needle valve—and the resultant wear to valve, seat, and other parts—is prevented by new design of float mechanism.

E. Number of moving parts is reduced by simplified float mechanism.

F. Larger screen, easily removed for cleaning without disturbing gasoline connection is provided.

This carburetor, of course, incorporates the trouble-free Zenith "fixed adjustment."

We shall be glad to send full details of the UF Zenith, and show you why it is a better carburetor for your equipment.

ZENITH-DETROIT CORPORATION

Manufacturer of

ZENITH CARBURETORS

DETROIT MICHIGAN

Branches:

NEW YORK · CLEVELAND · CHICAGO

Service Stations in over 800 cities

PERSONAL NOTES OF THE MEMBERS

Continued

Byron L. Keim, who was formerly secretary and sales engineer for the Automotive Parts Co., Pittsburgh, is now mechanical engineer for the Boiler Tube Co. of America, also of Pittsburgh.

Ralph S. Kellogg, who was until recently layout draftsman for the Dort Motor Car Co., Flint, Mich., is now affiliated with the A. C. Spark Plug Co., also of that city.

Robert J. Kenworth has been appointed sales representative for the Triple Action Spring Co., New York City. He was, prior to this, manager for the Perfection Spring Service Co., which is also located at New York City.

Stephen L. Kerr who formerly attended the University of Utah, Salt Lake City, has been made production manager of the Covey-Ballard Motor Co., also of that city.

Noah G. Klove has disposed of most of his interests in the Sherman-Klove Co., Chicago, where he was an officer and assistant manager for a number of years and will discontinue active participation in the affairs of the company. No announcement has been made of his future plans.

Louie F. Koellner, who until recently was assistant engineer for the Traffic Motor Truck Co., St. Louis, has accepted a position as assistant engineer in the research department of the Heine Boiler Co., also of St. Louis.

Arthur W. Koerber, who was previously associated with the O. E. Szekely Engineering Co., Moline, Ill., doing design, research and engineering work, has become a designer for the Yellow Sleeve Valve Engine Works, Inc., East Moline, Ill.

S. H. Hunter Kuenzel, who was formerly layout draftsman for the Frontenac Motors Co., Indianapolis, has accepted a position as engineer for Premier Motors, Inc., also of Indianapolis.

Paul Lacroix, vice-president of the Rubay Co., in charge of production, will continue at the head of the plant under the supervision of the new owner, the Baker R. & L. Co., Cleveland.

Edward C. Lange has become designer and engineer for the Hicks Engine Works, San Francisco. He was until recently chief engineer for the Union Construction Co., Oakland, Cal.

Dudley W. Leavitt, who was formerly purchasing agent of the Commodore Motor Corporation, New York City, is now associated with the Cap Screw & Nut Co., also of New York City, in a similar capacity.

Harold E. Lehman has been made sales engineer for the Wheeler-Schebler Carburetor Co., Indianapolis. Prior to this he was connected with the engineering department of the Stutz Motor Car Co. of America, also of Indianapolis.

R. W. Lytle, who was previously assistant chief engineer of the Stephens Motor Co., Freeport, Ill., is now engineer of the gear material division of the Formica Insulation Co., Cincinnati, Ohio.

Harry H. McCarty has been appointed instructor in mechanical drawing in the department of practical mechanics at Purdue University, West Lafayette, Ind. He was until recently mechanical research engineer for the General Motors Research Corporation, Dayton, Ohio.

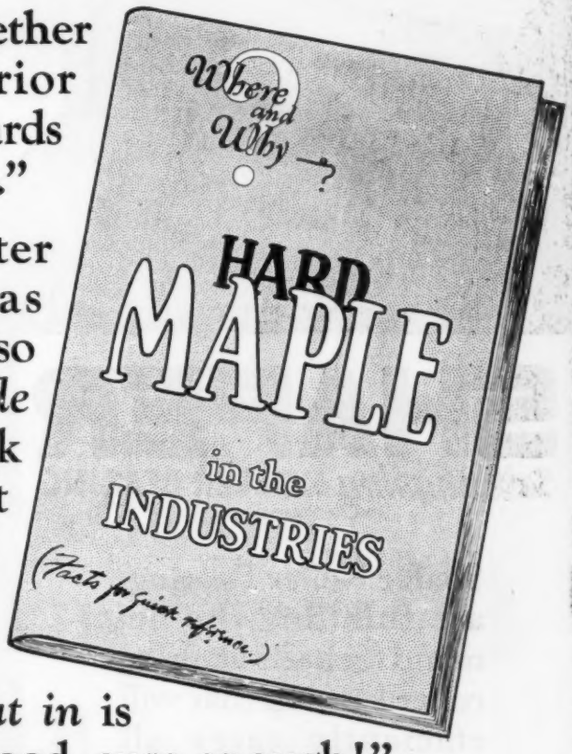
Oscar A. Malychevitch, who previously was associated with the Sokoma Co., New York City, as partner and engineer, is now connected with the engineering department of the International Motor Co., also of New York City.

William H. Meyers has accepted a position as draftsman in the structural steel department of the Hetherington & Berner Iron Works, Indianapolis. He formerly had a similar position with the Nordyke & Marmon Co., also located in that city.

(*Continued on p.* 10)

"Body-Mnfrs."? or—"COACH BUILDERS"?

Some people may put together an assortment of inferior wooden sticks and thin boards and call it an "auto-body."



OTHERS, who are better business-men as well as better craftsmen (and also better citizens), take a *pride in their product*, do fine work and will use nothing but HARD MAPLE for auto-body-construction.

A wood that screws, bolts and all fastenings *stay put in* is "The Rattle-proof Hardwood, sure enough!"

ALSO—"Save Freighting on Crating," by boxing every shipment with *low-grade* HARD-MAPLE.

Result: Less bulk, greater strength, neater appearance, and less damage in transit. Why not "*Pile up the goodwill*"?

New *thoughts* will spring from the reading of this booklet and from a study of the official statistics of strength (compression, shearing and tension) of American hardwoods—also, beam-tests, impact-bending; comparative weights of hard and soft woods, etc. Some of those new thoughts may be valuable. 32 illustrations, 2 colors throughout.

For your copy (with our compliments) please write, on letterhead, to

THE NORTHERN HARD MAPLE MANUFACTURERS
307 F. R. A. Building, Oshkosh, Wisconsin
307 Cummer-Diggins Building, Cadillac, Michigan

SHAFER
Self-Aligning ROLLER BEARING
PAT. & PATS.PENDING
Shafer Roller Bearings are fulfilling the demand for a self-aligning roller bearing that will efficiently carry all combinations of thrust and radial loads, applied from any angle.
Furnished in Interchangeable Sizes
SHAFER BEARING CORPORATION
6501 WEST GRAND AVENUE
CHICAGO, ILL.

PERSONAL NOTES OF THE MEMBERS

Continued

Claud S. Mobley is now designer for the Chevrolet Motor Car Co., Detroit. His previous business connection was with the Hupmobile Motor Car Co., also of Detroit, in a similar capacity.

A. L. Morgan has become assistant chief engineer for the Canada Sugar Refining Co., Montreal, Canada. Until recently he was body draftsman for the Parker Motor Car Co., Ltd., also of Montreal.

Joseph J. Muller has severed his connection with the Belmont Motors Corporation, Lewistown, Pa., as designing engineer, and has become service manager for the Lewistown Motor Co., Inc., which is also located in that city.

Joseph G. Murphy has accepted the position of works manager with the Welded Steel Barrel Corporation, Detroit.

Charles Nelson, Jr., is no longer draftsman for the Western Electric Co., Hawthorne, Ill., but has accepted a similar position with the U. S. Ball Bearing Co., Chicago.

Leonard V. Newton has become director of motor transportation for the Pure Oil Co., Columbus, Ohio. Prior to this he was superintendent of transportation for the Indian Refining Co., New York City.

H. N. Nigg, who was formerly general manager of the Frost Gear & Forge Co., Jackson, Mich., has been elected president and treasurer of the Republic Gear Co., Detroit.

M. Olbeter has become designer of aviation engines for the Wright Aeronautical Corporation, Paterson, N. J. His previous business connection was as an engine designer with the Lawrance Aero-Engine Corporation, New York City.

C. I. Overton has severed his connection with the Bassick Mfg. Co., Chicago, of which he was vice-president. No announcement has been made of his future plans.

R. R. Owen, who until recently was associated with R. M. Owen & Co., New York City, has been elected president of the Stevens-Duryea Motors, Inc., Chicopee Falls, Mass.

Arnold G. Parker has accepted a position as designing draftsman for C. H. Matthiessen, Jr., Long Island City, N. Y. He was formerly connected with Manly & Veal, New York City, in a similar capacity.

W. J. Pearmain, who was previously assistant chief engineer for the J. I. Case Plow Works Co., Racine, Wis., is now sales engineer for the Twin Disc Clutch Co., also of Racine.

Gordon R. Pennington is now manager of the truck equipment department of the Van Dorn Iron Works Co., Cleveland.

R. J. S. Pigott has accepted a position with Stevens & Wood, Inc., 120 Broadway, New York City. Prior to this he was works manager for the Crosby Steam Gage & Valve Co., Charlestown, Mass.

F. R. Pleasonton, president of the Bishop & Babcock Co., Cleveland, has severed his connection with that organization and is now affiliated with the General Motors Corporation, Detroit.

Karl Probst has resigned as chief engineer of the Milburn Wagon Co., Toledo. His plans for the future have not been announced.

E. N. Rahusen has joined the engineering department of the Sté An. des Automobiles et Cycles Peugeot, Levallois-Perret, France. He was previously designing engineer and assistant chief of the engineering department of the Ehrhardt-Szawe Automobilwerke A. G., Zella-Mehlis, Germany.

Nicholas G. Rost has become associated with the Climax Engineering Corporation, Clinton, Iowa, in the capacity of executive assistant. Until recently he was president of the Richelieu Motor Car Corporation, New York City.

Leon Rubay, who was formerly president and general manager of the Rubay Co., Cleveland, has retired and returned to France.

(*Continued on p.* 12)

DRIVING
IN HEAVY TRAFFIC
IS MADE EASIER
BY A FAST-SHIFTING
CLUTCH

The
Borg & Beck Company

920 Michigan Ave.

Chicago

CHICAGO MOLINE

SERVICE
FLOOD OILING
FAN

Without doubt the most desirable features to be found in a fan are quiet operation and freedom from attention.

These features are found in the Service Flood Oiling Fan. They are the results of a plain bearing running in a bath of oil.

Ten thousand miles or more elapse before the original oil supply needs replenishing.

Complete information and technical data will be sent on request.

Service Products Corporation
201 S. Rural St.
INDIANAPOLIS, IND.

"If it's a flood oiling fan it's a Service Fan"

Personal Notes of the Members

Continued

Walter J. Rudolph, until recently chief engineer of the Imperial Brass Mfg. Co., Chicago, has become affiliated with James P. Marsh & Co., also of Chicago, as factory superintendent.

Lynn L. Russell has been appointed lubrication engineer for the Texas Co., and is located at Chicago. He was previous to this experimental engineer for the Rich Tool Co., also of that city.

R. F. Russell is now associated with the American La-France Co., Elmira, N. Y. Until recently he was production engineer for the Urban Motion Picture Industries, Inc., Irvington, N. J.

Robert F. Schelling, who was formerly associated with the sales department of the E. H. Baker Corporation, Buffalo, is now secretary and treasurer of the A. F. Winegar Motor Corporation, also of Buffalo.

G. A. Schreiber is now mechanical engineer in the shop engineering department of the White Motor Co., Cleveland.

Charles M. Schwab has accepted a position as designing engineer for the Porter Engine Development, Inc., New York City.

Raymond W. Scott has been made superintendent of service with the W. L. Eaton Co., Seattle, Wash. He was previously president of the Yakima Grinding Co., Yakima, Wash., and more recently sales manager of W. E. Dooley & Co., also located at Seattle.

Byron H. Seaverns is engaged in consulting engineering in Chicago. Prior to this he was designing engineer for the United States Gypsum Co., also located in Chicago.

Frank Short, who was until recently ordnance engineer located at Aberdeen Proving Ground, Md., has been elected vice-president and general manager for the General Service & Engineering Co., Inc., New York City.

Charles S. Slaker has organized the Slaker Health Food Co., Indianapolis. His previous business connection was with the Premier Sales Co., also located at Indianapolis, as its president.

A. R. Small, vice-president of the Underwriters' Laboratories, Inc., Chicago, has been transferred to the New York City office of that organization.

E. F. Smeckel has severed his connection with the American Steam Truck Co., Elgin, Ill., where he was engineer in charge of automotive equipment. No announcement has been made of his future plans.

Horatio W. Smith, vice-president and works manager for the National Axle Co., San Jose, Cal., has resigned and is now president and general manager of the Great Western Motors, Inc., which is also located at San Jose.

T. D. Smith has been appointed manager of the Detroit office of the Proof Machine & Brass Foundry Co., Cleveland. His previous connection was with the Harvey Electric Co., Chicago, where he held the position of sales manager.

L. H. Snyder, who was until recently manager of the lubricating department of the Joseph Dixon Crucible Co., Jersey City, N. J., has opened an office in Chicago, for the practice of consulting engineering.

R. O. Sperry has become affiliated with the Philadelphia Bronze Bearing & Tube Co., Philadelphia, and will assume the general management of the business. He was formerly manager of the rod, sheet and tube department and Eastern sales manager for the American Bronze Corporation, Berwyn, Pa.

(*Concluded on p.* 14)

SERIAL NUMBERS

BROWN-LIPE GEAR SERIAL NUMBERS —Your Safeguard

YOU may find the serial numbers sometimes painted over but they are stamped on all Brown-Lipe Gear units as follows:

Unit Power Transmissions—On the forward top side of the case, to left of center and either under or immediately in front of the cover; also on top of the cover near the left edge.

Main Frame Transmissions—On the top surface of the left rear supporting arm; also on top of the cover, near this arm.

Clutches—On top of the left side boss for the release shaft.

Controls—Unit power type, on top of the cover, near center. Main frame type, on edge or top of the bracket.

Never use anything but Genuine parts with Brown-Lipe Gear units.

Service may be obtained from manufacturers using our units, authorized parts service stations or direct from our factory.

BROWN-LIPE GEAR CO.

BROWN-LIPE GEAR COMPANY

SYRACUSE, N. Y.

San Francisco Chicago Detroit New York London, Eng.

IT is a recognized fact that fibre for electrical purposes must have certain very definite physical and chemical qualities.

And in the interests of economy in handling, as well as efficiency in performance, you must have the right grade of fibre for each particular piece of work.

The grading of fibre, so that the right selection is possible, means adequate facilities for producing the many varying grades needed in electrical work.

The National Vulcanized Fibre Company's six great mills, devoted solely to the production of fibre, fibre parts and specialties, constitute the largest plant of its kind in the world.

You can be assured of getting the grade of fibre that exactly meets your every need.

Our Service Testing Department fibre experts are at your service in helping solve any fibre problem that confronts you, and can assist by selecting from the many National Fibre grades, one that may give you greater efficiency in performance than the grade you are now using.

NATIONAL VULCANIZED FIBRE CO.

Wilmington, Del., U. S. A.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH CLEVELAND CHICAGO DETROIT SAN FRANCISCO ROCHESTER BIRMINGHAM DENVER TORONTO GREENVILLE ST. LOUIS BALTIMORE

PERSONAL NOTES OF THE MEMBERS

Concluded

George A. Streicher is now engineer for the Automatic Burner Co., Milwaukee. Prior to this he was sales engineer for the Titan Truck Co., also of Milwaukee.

Frank W. Sutton has severed his connection with the Charles E. Bedaux Co., Cleveland, where he was chief engineer. His plans for the future have not been announced.

Fred Taylor is now development engineer for the General Fireproofing Co., Youngstown, Ohio. He was formerly sales engineer for the Hahn Mfg. Co., Cleveland.

John E. Terhune, who was until recently factory manager for the Cox Brass Mfg. Co., Albany, N. Y., now holds a similar position in the bumper division of the Eaton Axle & Spring Co., Cleveland.

Raymond E. Tetens has accepted a position as full sized body draftsman for the Studebaker Corporation of America, Detroit. He was formerly draftsman for the Reo Motor Co., Lansing, Mich.

Henry A. Tuttle has been appointed consulting engineer for the Paragon Gear Works, Taunton, Mass. Prior to this he was president of the Engineering Service Corporation, Detroit.

B. W. Twyman, who was previously general manager of the Nash Motors Co., Milwaukee, has organized the Twyman Remanufacturing Motors Co., Indianapolis, of which he is president and general manager.

Harvey E. Tyler has resigned as instructor in the fundamentals department of the automobile mechanics school of the Ambu Engineering Institute, Chicago, and is now associated with the research department of the Stewart-Warner Speedometer Corporation, also of that city.

F. M. Vandervoort, who until recently was designing engineer for the Baker Steam Motor Car Mfg. Co., Pueblo, Colo., has accepted a position with the Silver Mfg. Co., Salem, Ohio.

Herbert von Frankenberg has been appointed salesman of automobile upholstery fabrics for Collins & Aikman, New York City.

R. C. Voorhees has become affiliated with the Commerce Motor Truck Co., Ypsilanti, Mich.

Henry W. Warford has accepted a position with the Packard Motor Car Co., Detroit. Formerly he attended Tri-State College, Angola, Ind.

Nathaniel Warshaw, who was formerly chief engineer for the Murray-Tregurtha Corporation, Atlantic, Mass., has become affiliated with the Taylor Mfg. Co., Cambridge, Mass., in a similar capacity.

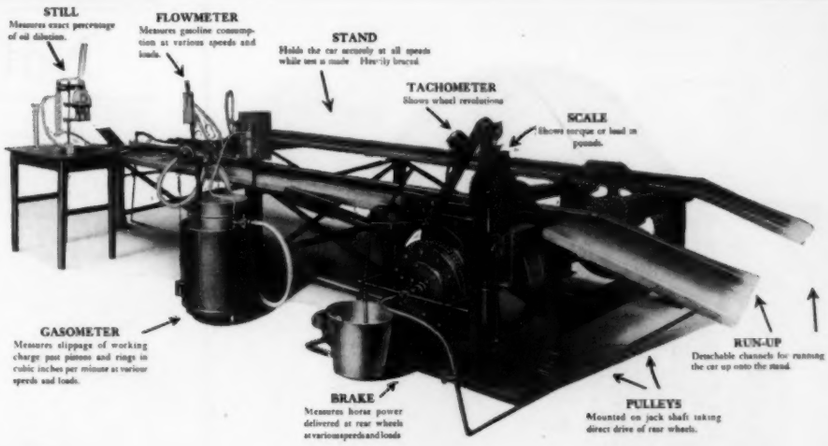
Don B. Webster has been appointed manager for the Webster Equipment Co., Indianapolis. He was until recently district manager of the motor bearings division of the Hyatt Roller Bearing Co., Detroit, with headquarters at Indianapolis.

William B. Wheatley is engaged in business for himself at Brooklyn, N. Y., repairing automobiles, giving driving lessons and making reports on used cars for sale. He was previously service foreman for the Hunt Motor Car Co., which is also located in Brooklyn, and prior to that he was instructor in mechanical engineering at the Stewart Auto School, New York City.

Karl H. White, who was previously aeronautical engineer for the Aeromarine Plane & Motor Co., Keyport, N. J., is now affiliated with Huff, Daland & Co., Inc., Ogdensburg, N. Y.

Wilford W. Wing has accepted a position as general foreman with the National Carbon Co., Long Island City, N. Y.

There has been a great deal of talk about it—some of it misinformed. It has been discussed in trade papers by able engineers. It has not been possible to keep private the remarkable tests it has been put through in a number of prominent service stations. This is the first official statement to the trade and the automotive industry, giving the authentic facts about R. B. Wasson's remarkable invention.


STILL
Measures exact percentage of oil dilution.
FLOWMETER
Measures gasoline consumption at various speeds and loads.
STAND
Holds the car securely at all speeds while test is made. Heavily braced.
TACHOMETER
Shows wheel revolutions
SCALE
Shows torque or load in pounds.
GASOMETER
Measures slippage of working charge past pistons and rings in cubic inches per minute at various speeds and loads.
RUN-UP
Detachable channels for running the car up onto the stand.
BRAKE
Measures horse power delivered at rear wheels at various speeds and loads
PULLEYS
Mounted on jack shaft taking direct drive of rear wheels.

Authentic Facts about the

Wasson Motor Check

THE Wasson Motor Check is a complete testing unit that measures with scientific accuracy the performance of a motor in every essential factor, including the following most important items: horse-power delivered at the rear wheels; slippage past rings and pistons in cubic inches per minute; compression in each cylinder; dilution of oil in percentage. If the motor is not right it tells why and where with mechanical precision.

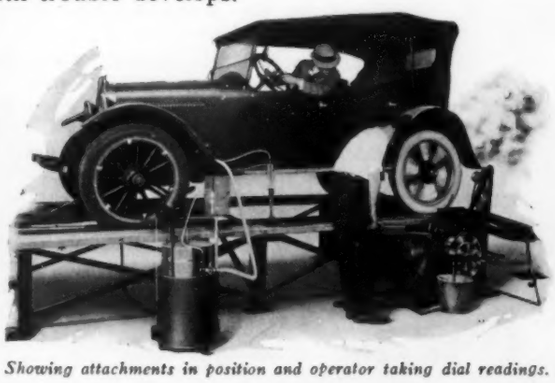
Repair men can diagnose any case by a careful interpretation of the Motor Check findings. That saves all needless expense of cut-and-try methods. After the engine has been brought back to standard —the Motor Check proves the job.

Dealers can place a true performance value on trade-in-cars by using the Motor Check. It can't fake the result. It provides a basis of confidence for the buyer and seller both. You can honestly certify car condition.

Distributors of motor accessories can prove the relative value of their products by comparative tests on actual cars—under any conditions of load or speed desired. No rule-of-thumb — but specific proof.

Producers of fuel and lubricants can show by graphic demonstrations the quality of their product and its most efficient use.

Fleet owners can maintain every unit of their fleet, at minimum expense, by a simple system of periodic tests on the Motor Check. No waiting until trouble develops.



Showing attachments in position and operator taking dial readings.

Car manufacturers can establish standards of car performance and life by Motor Check measurement and Service Stations can repair or adjust to this standard by following Motor Check indications.

In a word it discloses cause and effect of motor inefficiency. *Cause and Effect*—the scientific basis for all corrective work—in mechanics as in medicine. Isolate the trouble and you can cure it.

The Wasson Motor Check is a basic contribution to the automotive industry, and its adoption and intelligent use will answer the car servicing problem, the reconditioning problem and the used car problem.

Skeleton Description

The essential apparatus consists of (a) a rigidly built stand, with run-up, on which the car is anchored; (b) an adjustable brake upon which the rear wheels are driven, registering speed and horsepower on simple dials; (c) a gasometer attached to breather, measuring slippage past the pistons; (d) a flowmeter measuring fuel consumption under any load conditions; (e) a "still" to measure crank case dilution; (f) a gauge to establish compression; (g) spray valve and condensing plate to determine at what motor speed liquid oil is passed.

Supplemental equipment includes a gauge to establish back pressure and muffler conditions; an apparatus to analyze (for per cent of CO_2) the exhaust gases.

Time—A complete test may be run in less than one hour.

Weight—The Motor Check scales a little under 2000 lbs.

Size—Stand with run-up—25 ft. x 6 ft. x 3 ft.—Working space required about 300 sq. ft.

The Wasson Motor Check is leased to the trade under specific provisions, and is fully covered by patents pending in the U. S. Patent Office. Send for engineering data and terms.

T-N-T Engineering Co., Inc., Newark, N. J.
Manufacturers of T-N-T Piston Rings and the

Wasson Motor Check

The Kelly-Springfield Commercial Truck Cord —a real truck pneumatic

At last we are able to offer a pneumatic truck tire that is more than a "glorified passenger car tire."

This new tire, the Kelly-Springfield Commercial Truck Cord, is radically different from the ordinary pneumatic. The cord fabric is stronger, the rubber compound is tougher, the tread is sturdier and the method of building is such as to produce a tire of remarkable wearing quality.

In actual service under conditions more severe than the average truck will ever encounter Kelly Commercial Truck Cords have given consistently high mileage and some of them are still in service after running more than 30,000 miles.

The greater mileage, service and safety which the Kelly-Springfield Truck Cord assures will be welcomed by truck owners in states where the road laws discriminate in favor of pneumatic-equipped vehicles, and also by those whose trucks operate under conditions which make the use of pneumatic tires almost a necessity.

An inquiry addressed to our Engineering Service Department will bring you full details regarding the construction and advantages of this new tire.

Kelly-Springfield Tire Company
250 West 57th Street, New York

Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

MOTOR VEHICLES AND THEIR ENGINES. By Edward S. Fraser and Ralph B. Jones. Published by D. Van Nostrand Co., New York City. 374 pp.; 319 illustrations.

This book, the revision of the first or 1919 edition, is presented as (*a*) a guide for the personal instruction of the car-owner, (*b*) a handbook for chauffeurs and repairmen and (*c*) a textbook for automobile schools. In it are explained the principles of operation of the various units included in an automobile. Descriptions of the units and accessory devices are also given. Carbureters are given special attention in three chapters which cover 57 pages. Other chapters are devoted to proper driving, engine troubles, lubrication, care and adjustment. A useful set of tables on care and adjustment of different makes of cars is included.

THE MOTOR TRUCK. By Edward E. LaSchum. Published by the U. P. C. Book Co., Inc., New York City. 325 pp.; 67 illustrations.

Mr. LaSchum's book is written with the truck operator always in mind. It is meant to cover in an unbiased manner the important features of motor-truck operation in such a way as to be of immediate use in the solution of practical everyday problems that at one time or another may confront every operator. An idea of the scope of the work can be gained from the following enumeration of chapter headings: The Field of the Motor Truck, The Powerplant, Carbureters, Electrical Equipment, Radiators, Lubrication, Fuel and Heat, The Chassis, Running-Gear, Performance, Record of Performance and Maintenance.

ELECTRICITY AND ITS APPLICATION TO AUTOMOTIVE VEHICLES. By Paul M. Stone. Published by D. Van Nostrand Co., New York City. 844 pp.; 395 illustrations.

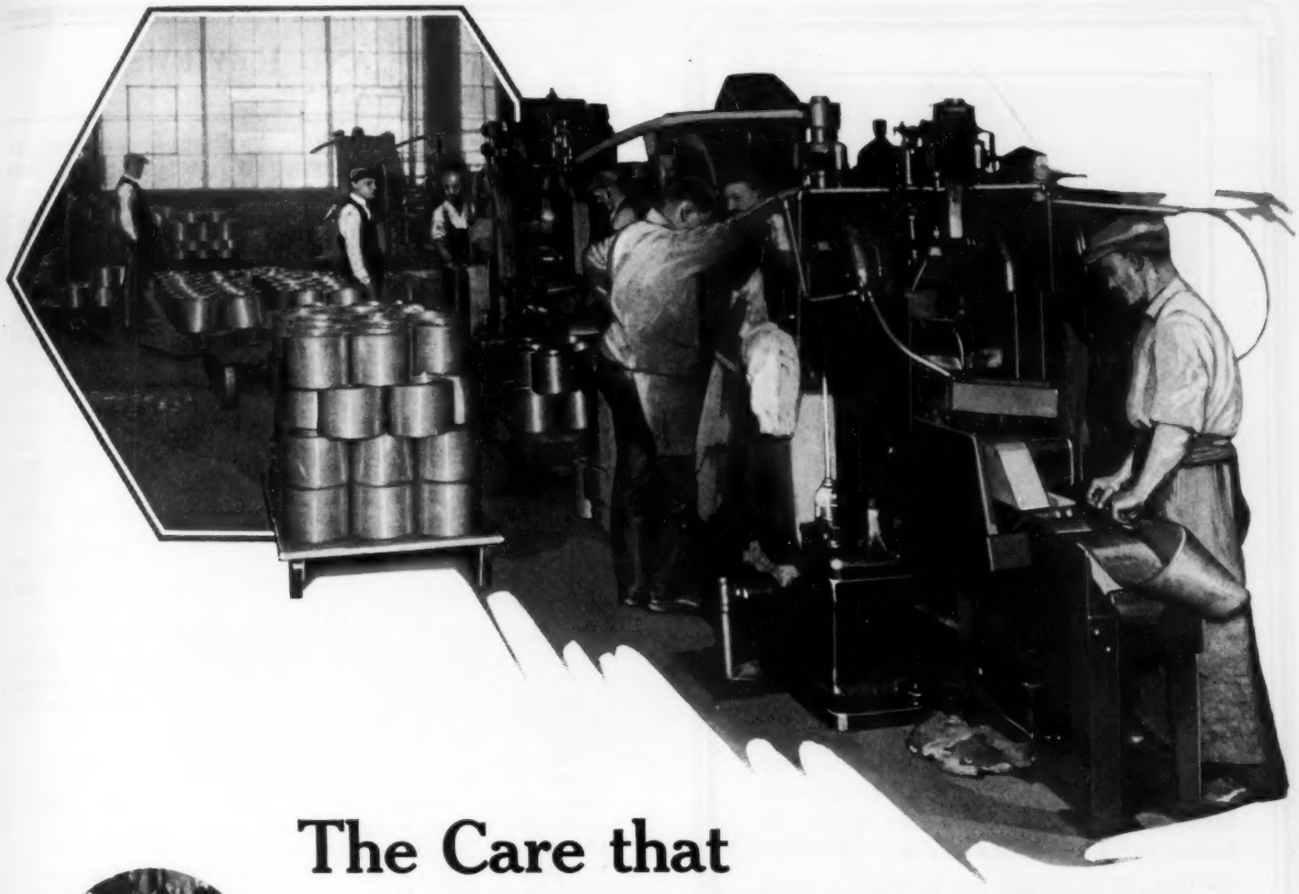
The first three chapters of this work, which should be of great value to students and others interested in the electrical features of automobiles, are assigned to a consideration of magnetism and elementary electrical principles; electromagnetism is covered in a later section. Among the chapters that follow are those devoted to force, work, energy and power; electrical circuits; sources of electrical energy for ignition and other uses, including batteries, generators and magnetos; electrical measuring and testing instruments; a description of electrical devices and an explanation of the principles involved therein; mechanical features; illumination; trouble-shooting. Some 20 chapters contain individual illustrated descriptions of as many electrical systems used on automobiles now in service.

Altogether this book offers a mass of very interesting and valuable information, logically arranged for handy reference.

FARM EQUIPMENT FOR MECHANICAL POWER. By Frank N. G. Kranich. Published by the Macmillan Co., New York City. 401 pp.; 320 illustrations.

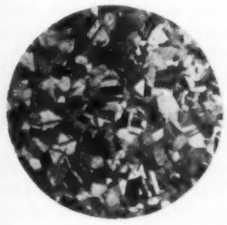
This book, based upon actual field experience and observation of farm machinery and its operation, is presented as an aid to the student, to the builder of farm equipment, to the dealer, the distributer and the service-man and primarily to the farmer himself. It contains numerous descriptions of farm machinery and implements, with interesting discussion of their application and use. Part I treats of draft machinery, Part II is concerned with belt-driven machinery and Part III, which is devoted to miscellaneous topics, has chapters on engine cultivators, garden tractors, lubricants and lubrication, tools and shop equipment and ordering repair parts.

(*Continued on p.* 18)



The Care that Guards Harrison Quality

Coarse, uneven grain-size. Structurally weak. Due to improper manufacturing control.



Fine grain. Developed by close control of fabricating process.

The enduring high quality of Harrison Radiators—their ability to serve dependably year after year for the life of the motor car—is the direct result of the exacting standards of manufacture that prevail in the Harrison factory.

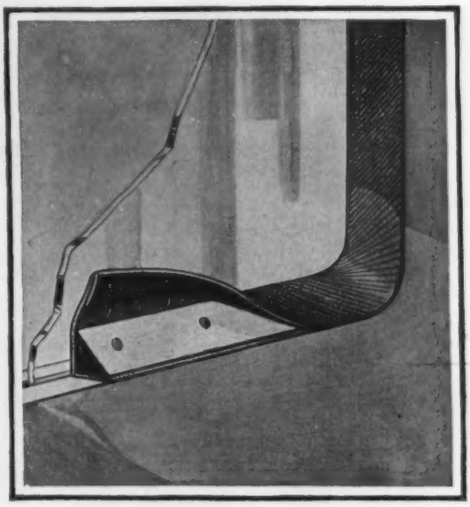
Long before the actual manufacture and assembly of the radiator can be begun—innumerable mechanical operations are necessary to prepare the brass used in making Harrison cores.

Harrison Radiator Corporation operates its own brass rolling mill as an integral part of its great plant. Specially trained workmen, the best of machines and furnaces, and extremely careful control of operation produce thin brass of the quality shown by the second micrographic illustration. No other quality is considered fit for Harrison requirements.

The same scrupulous care exercised in rolling and annealing brass used in Harrison cores is followed in every process of manufacturing complete Harrison radiators. The value and importance of this care have been demonstrated for many years in the superior efficiency and higher quality of Harrison radiators—an efficiency and quality that are directly responsible for the fact that so many of the finer motor cars are Harrison-equipped.

Harrison Radiator Corporation
Lockport, New York

HARRISON RADIATORS



Rattle Proof Windows!

for your closed models

After the closed car has been over rough roads and subjected to strenuous duty the windows will not rattle and jar if they are cushioned with Wire On Tri-Angular Moulding. It is a recent innovation for motor car builders from The House of Carter. It cushions the glass in a fixed position by conforming to it. Wire On Tri-Angular Moulding is as lasting as the car itself.

ECONOMICAL

Wire On Tri-Angular Moulding is applied quickly and easily. Oval or rectangular windows are fitted equally well. Wire On Tri-Angular Moulding is held in position by tacks through the tri-angular rubber strip which occupies one-half of the moulding—the other half folds over, concealing the tacks and all rough edges. Wire On Tri-Angular Moulding is made from any specified material. Write for samples and quotations on your requirements.

WIRE ON PRODUCTS

Patented U. S. August 16, 1921
Canada July 25, 1922

The Geo. R. Carter Co.
CONNERSVILLE, INDIANA

Since 1896 The House of Carter has supplied quality trimming materials to the upholstery trade. Get our catalog. In it you will find a product for every trimming need.

NOTES AND REVIEWS

Continued

HANDBOOK OF AUTOMOBILES, 1924. Published by the National Automobile Chamber of Commerce, New York City. 230 pp.; illustrated.

As stated in the preface, this annual handbook of automobiles contains the principal specifications of 141 passenger automobiles, 66 commercial cars and trucks and 5 electric vehicles, produced by leading builders who are members of the National Automobile Chamber of Commerce. The appearance of cars and their cost, together with principal mechanical details and standard equipment, can be ascertained from the illustrations and the specifications given.

REPORT OF THE NATIONAL PHYSICAL LABORATORY FOR 1922. Published by His Majesty's Stationery Office for the Department of Scientific and Industrial Research. 230 pp.; illustrated.

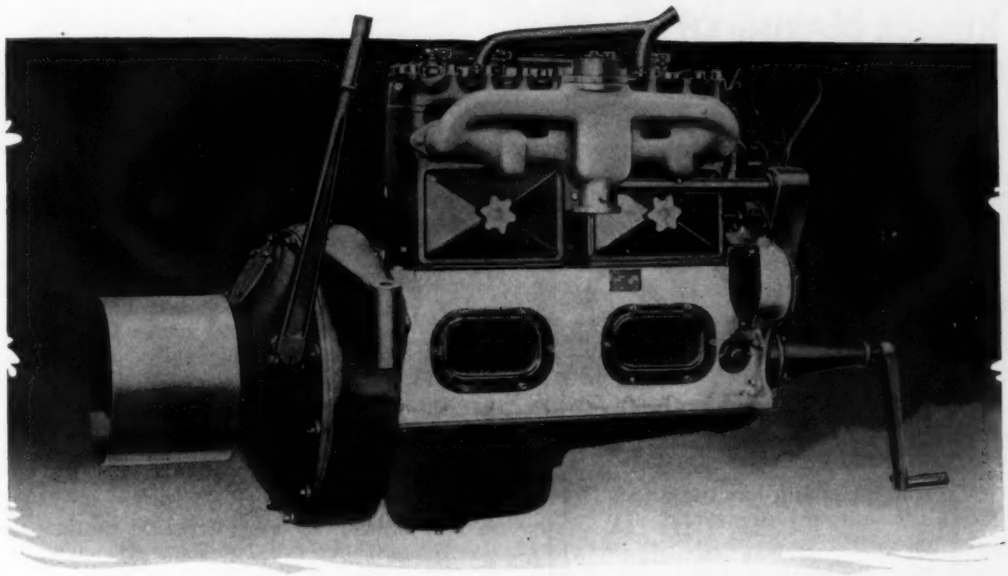
The report of the Director for 1922 describes the work in the departments of physics, electricity, metrology, engineering, aerodynamics and metallurgy. The space of 12 pages is devoted to a statement of work proposed for 1923 and 1924.

The report from the metrology department contains a description of a gear-measuring machine, constructed to make possible the separate measurement of the various elements of a gear, in any of which errors may occur independently of the other elements. The description is as follows:

> The gear wheel, mounted on an arbor, is placed on a pair of centers, and measurements are made by a steel ball in contact with the gear tooth. The ball forms the end of a stylus attached to a special form of indicator, which may be moved in three directions mutually at right angles. For this purpose the machine is in three main portions, namely, the base, a lower carriage running on ball races on the base at right angles to the axis of the gear and an upper carriage moving across the lower carriage on ball races parallel to the gear axis. The movement of each carriage is controlled by a micrometer screw reading to 0.0001 in. Adjustable stops enable the micrometers to be used for all positions of the carriages. The indicator is held in a conical seating on the upper carriage.
>
> The indicator consists essentially of a light lever suspended by two pairs of crossed flexible steel strips. The stylus forms the short arm, and the long arm is a steel pointer having a bevelled sector at the end. A micrometer attached to the frame of the indicator can be advanced toward the sector and observed by a magnifying prism against an illuminated ground glass window. The ratio of the lever is 5 to 1, and it provides a means for measuring accurately small changes in the height of the stylus ball.
>
> The left-hand micrometer is used to move the lever bodily in a vertical direction. For this purpose the suspension strips of the lever are attached to a steel plate that has a vertical travel of 1 in. on ball races on the end-plate of the indicator frame. The movable plate receives an inclined thrust from a pointed strut, the horizontal component holding it firmly on the balls and the vertical component causing it to bear either upward or downward on the flank of the gear tooth.
>
> The spindle carrying the left-hand center has attached to it a device for accurately rotating the gear wheel by known amounts. For this purpose the arbor and the spindle are connected together by a special coupling piece that has the necessary rigidity without putting strain on the center.
>
> For some purposes a special form of pantograph is used to take a record of the tooth form. This occupies the same conical seating in the upper carriage.

(*Continued on p.* 20)

SKF



Ball Bearings on Power Take-Off
Prevent Undue Wear—Reduce Maintenance

IF appreciable friction exists in power take-off bearings of motor trucks, tractors, etc., binding and undue heating occurs and the bearings wear rapidly requiring frequent adjustments and replacements.

But when Skayef self-aligning ball bearings are used these troubles are avoided. So little wear occurs that the initial accurate setting of the shaft is maintained indefinitely without need of adjustment. This freedom from wear is due to the extremely low co-efficient of friction of this type of bearing, the use of special high alloy steel hardened uniformly throughout and the exclusive inherent ability to compensate automatically for shaft deflections without the setting up of internal bearing strains.

Because of their precision, heavy load carrying ability and superior performance, **SKF** marked ball bearings are pre-eminently suited for use on all vital automotive parts. The wide experience of our engineers in applying ball bearings to automotive parts is at your disposal in solving your specific problems.

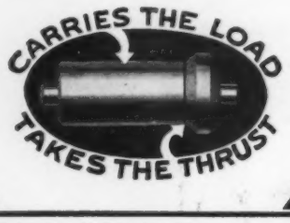
THE SKAYEF BALL BEARING COMPANY

Supervised by **SKF** INDUSTRIES, INC., 165 Broadway, New York City

1115

Normal View *Deflected View*

BOWER
ROLLER BEARING CO.
Detroit · Michigan



Mr. Engineer:—

What design in a bearing has the most advantages for your problems?

Does not a bearing having capacity for both radial and thrust loads meet your requirements?

Bower design has incorporated thrust and radial carrying surfaces in the Bower Roller Bearing. These surfaces are separate and independent. Besides Bower Roller Bearings do not need adjustment. Bower Bearings never jam.

Bower Roller Bearing Company
DETROIT, MICHIGAN

NOTES AND REVIEWS

Continued

The method of using the machine to measure the various elements of spur and other gears is explained, the following features receiving attention: pitch, tooth form and thickness, concentricity of teeth with axis, parallelism of teeth with axis, radial symmetry of teeth, pitch-diameter, helical gears, bevel gears, variations from uniform motion when a pair of gears is rotated in mesh and the theoretical effects of errors of various types on the action of gears.

The statement of proposed work includes experiments with the new gear-measuring machine to investigate the errors in various processes of gear cutting, the effects of wear with different types of teeth and conditions of running, the effects of hardening with and without grinding and the effect of errors on the silence and the efficiency of running under different conditions.

A piece of proposed work in the engineering department for the Lubrication Research Committee deals with cylindrical lubrication, continuing research already begun, investigating the friction of lubricated surfaces whose relative motion is a combination of sliding and rolling and studying the behavior of Aquadag as a lubricant for sliding surfaces in the presence of superheated steam.

A new asphalt mixing plant, provided by the Government, will be used for an extensive series of endurance tests in the road-testing machine, the tests to proceed continuously throughout the year.

THE MISUSE OF THE INTERNAL-COMBUSTION ENGINE AND SUGGESTIONS FOR ITS MORE EFFICIENT APPLICATION. By L. Murphy. Published in *Automobile Engineer*, December, 1923, p. 409.

In the belief that few engineers have attempted to decide the question as to what must be the ultimate objects in road-vehicle design, Mr. Murphy undertakes to enumerate the shortcomings of current practice and to suggest numerous lines of possible improvement. The two chief disadvantages of present motor-vehicles mentioned in the article are the waste of time and the waste of fuel.

Among the various possible means for improving performance from both the time and the economy standpoint, the following are mentioned: variable transmission, variable-compression engines, gasoline engine and electric drive, and a combination of internal-combustion and expansion engines. Considerable space is devoted to a discussion of Durtnall's suggested arrangement of the latter combination. The article is illustrated with tables, charts and diagrams.

A GRAPHICAL STUDY OF JOURNAL LUBRICATION. By H. A. S. Howarth. Published in *Mechanical Engineering*, February, 1924, p. 77.

This paper visualizes the characteristics of the oil film and the pressures within it for a journal completely surrounded by its bearing. The influences of clearance and viscosity upon the journal friction are quantitatively shown by a chart that can readily be used for designing bearings. Several interesting examples are solved by this chart. A few of the characteristics of the journal partially surrounded by the bearing are also shown by curves.

ELEMENTS OF THE CITY TRAFFIC PROBLEM REVIEWED. By J. Rowland Bibbins. Published in *Engineering News-Record*, Jan. 3, 1924, p. 12.

Advocating a basic study of the whole traffic situation, the author shows that the problem is one that concerns all citizens and is of especial interest both to insurance companies because of the tremendous savings possible in decreasing the loss of life and of property, and to the motor-vehicle industry because of the equally tremendous obstruction to the normal growth of its business. The technical elements of the problem are cited and eight recommendations are made, including the following:

(*Continued on p.* 22)

DéJon

Starting, Lighting and Ignition System

is created for those builders of fine motor cars who seek to give their clientele the highest degree of perfection. Tests made by one of the foremost builders show, among other DéJon superiorities, a saving of 100 amperes in the cranking current, an increase in the cranking speed and a much higher starting torque ~

DéJON ELECTRIC CORPORATION
Builders Ignition Technique
POUGHKEEPSIE, NEW YORK

The STARTING MOTOR

Deppé Motors Corporation Superheated Gas System

(Patented)

This system in cars of the 3000 lb. class with engine displacement of 250 cubic inches gives results as follows:

With 100 lb. Compression

Fixed Superheated Gas Mixture

Fixed Adjustments in All Parts with Controlled Combustion

Develop maximum speed of 60 M.P.H.

Twenty-two miles per gallon with existing or any future motor fuels.

Sixteen hundred miles per gallon of lubricant.

Ten to 30 M.P.H. in 9 seconds.

Radiator water normally around 130° F.

NO THERMOSTATS

Easy starting, no loading.

Practically eliminates carbonization.

No preignition, no autoignition.

No so-called detonations.

Eliminates vibration due to fuel conditions.

Practically eliminates lubricating oil dilution.

No overheating of metals.

Practically eliminates valve grinding.

Practically eliminates bearing adjustments.

Practically eliminates spark-plug troubles.

PRACTICALLY ELIMINATES GEAR SHIFTING.

Deppé Motors Corporation

151 Church Street

New York City

NOTES AND REVIEWS

Continued

Plan now for a city of double the present size, without stopping to quarrel at just what date that event will take place. It will be sure to come too soon.

Make the transportation plan, above all, a continuing development linked in with the public-works program and considered in the same category as construction and finance.

HOW CAN FLEET OWNERS REDUCE ACCIDENTS? Published in *Motor Transport*, Jan. 15, 1924, p. 396.

After showing the cost, in money and otherwise, of commercial-vehicle accidents, this article gives an analysis of traffic accidents in New York City and makes a comparison with other cities in an endeavor to answer the questions as to who is responsible for this enormous social and economic loss and as to how it can be prevented. One conclusion that is drawn is that stricter regulation of pedestrian traffic is an urgent need.

NEW DESIGNS MAKE PROVISION FOR SERVICE. By J. Willard Lord. Published in *Automotive Industries*, Jan. 10, 1924, p. 70.

The trend of automobile design, as seen at the automobile show is surveyed from the viewpoint of a service-man. For example, the author considers four-wheel brakes with reference to the question of how much they will raise the cost of relining and adjusting brakes. In answering this question he states that it has been found that on cars using four-wheel brakes for some time, the actual expense to the owner for adjustment and replacement is not any more than on the two-wheel types, because of the fact that the braking effort is distributed over four bands, with the result that each band receives less strain and wear than would ordinarily be the case. Balloon tires, it is believed, will present no new problem to the service-man, except perhaps that some of the tire-changing machines will not be able to take care of the new tires; in this connection, however, the point is made that balloon tires will not be wearing out in sufficient numbers to constitute much of a problem to the service-man during the next 12 months, at the end of which time many of the tire-changing machines now in operation would in any case need replacing. Other topics considered include lubrication of the engine, crankcase draining, chassis lubrication and head-lamp adjustment.

WHAT THE SHOW MEANS TO THE SERVICE-MAN. By M. Ray Stehley. Published in *Automobile Topics*, Feb. 2, 1924, p. 1326.

Two reasons are given for the statement that the period immediately after the automobile show is a propitious time to institute a service-sales campaign: (*a*) everyone is in an "automobile" frame of mind and (*b*) through the medium of the displays, owners have learned more about the operation of cars and are more likely to understand the value of proper lubrication and care and to appreciate subsequent service work. The author tells of the means adopted by one company to impress upon car-owners the value of service, with special emphasis on the securing of winter business. A letter sent out in this connection is reproduced, and a card-index system is described. The part that service is playing in sales is stressed.

A CONSTANT-PRESSURE BOMB. By F. E. Stevens. National Advisory Committee for Aeronautics Report No. 176. Published by National Advisory Committee for Aeronautics, City of Washington. 8 pp.

This report describes a new optical method suitable to the study of the kinetics of explosive gaseous reactions. The method substitutes for the mechanical complications of a manometer placed at some distance from the seat of the reac-

(*Continued on p. 24*)

Valentine's Super-System of Automobile Finishing

You undoubtedly realize the owner demand for greater durability in automobile finishes.

You undoubtedly would like to satisfy that owner demand if you knew how.

You undoubtedly would be interested in a system of finishing that will add from 100% to 400% to the life of the finish of your car.

You undoubtedly would be surprised to learn that in many cases this added life can be obtained without increasing your time schedule and with an actual decrease in labor cost.

You undoubtedly would be interested in the fact that Valentine's Super-System is at present in use in large production and with astonishingly satisfactory results.

Write for full particulars.

TRADE VALENTINES VARNISH MARK

VALENTINE & COMPANY

Established in 1832

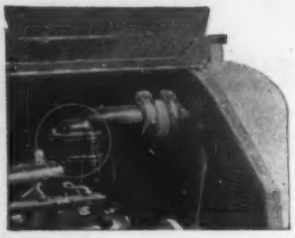
Largest Manufacturers of High Grade Varnishes in the World

New York
456 Fourth Ave.

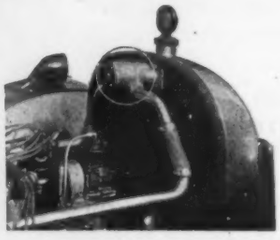
Chicago
343 S. Dearborn St.

Boston
49 Purchase St.

Standard Equipment
on all these cars



As installed on Pierce-Arrow



As installed on Cunningham

American:
Cadillac
Cunningham
Lafayette
Lincoln
Packard
Paige-Detroit
Pierce-Arrow
Premier

Foreign:
Fiat
Lancaster
Leland
Napier
Rolls-Royce
Straker-Squires
Vauxhall

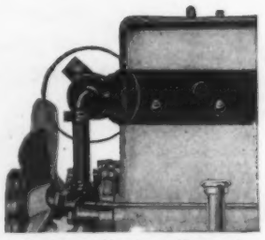
Trucks:
Vulcan
and many other cars and trucks.

Sylphon TRADE MARK
AUTOMOBILE
TEMPERATURE REGULATOR

This Sylphon Automobile Regulator controls the temperature of the cooling medium and greatly reduces the wear of valves, pistons and cylinders. It reduces crank case dilution and carbon deposits to a minimum and *saves* 15 to 20% in gasoline.

As installed on Kissel Kar

Self-contained, it has but three main parts: the Sylphon—that *seamless, solderless,* flexible all-metal expansion member which is the heart of all Sylphon products; a valve and a housing for the Sylphon. Self-regulating, adaptable to pump or Thermo-Syphon systems. We are the originators, patentees and sole manufacturers.



As installed on Premier

Send for Bulletin JUR.

THE FULTON COMPANY
KNOXVILLE, TENNESSEE
New York Chicago Detroit Boston Philadelphia
Representatives in all Principal Cities

NOTES AND REVIEWS
Continued

tion the possibility of allowing the radiant effects of the reaction to record themselves directly upon a sensitive film.

It is possible that the device may be of use in the study of the photo-electric effects of radiation. The method makes possible a greater precision in the measurement of normal flame velocities than was previously possible.

An approximate analysis shows that the increase of pressure and density ahead of the flame is negligible until the velocity of the flame approaches that of sound.

NEW YORK ADOPTS VIALOG TEST FOR SMOOTHNESS CONTROL. Published in *Engineering News-Record,* Jan. 10, 1924, p. 74. Illustrated.

This paper consists of the following short articles: Smoothness Requirements in New York, by Frederick Stuart Greene; Vialog Operation and Graphs, by Harley Dunbar, and a Discussion of Smoothness Surveys, furnished by the New York State Bureau of Roads.

The vialog, an aluminum instrument attached to an automobile to inscribe graphs of irregularities in the road surface over which the car runs, is described in detail, and graphs made by the vialog are reproduced.

THEORY AND CALCULATION OF HIGHWAY-TRANSPORTATION COST. By T. R. Agg. Published in *Engineering News-Record,* Jan. 10, 1924, p. 54.

The author shows that the costs accruing on account of the highway are closely related to those that accrue on account of the vehicle and that the two very often vary together. The economic life of the road is analyzed, and formulas are developed from which it is possible to determine (*a*) the vehicle cost per ton-mile for any type of surface and (*b*) the cost of the highway per ton of traffic. The addition of these two quantities will of course result in the total cost of highway transport.

VARIABLE TRANSMISSIONS, A CRITICAL CONSIDERATION OF THE PROBLEM. By G. Constantinesco. Published in *Automobile Engineer,* December, 1923, p. 396, and January, 1924, p. 10.

In continuing the discussion of mechanisms intended for variable transmission, begun in Part I of this paper which appeared in the November, 1923, issue of the *Automobile Engineer,* Mr. Constantinesco analyzes mathematically the action of several proposed contrivances. He groups the various forms of mechanical, frictional and hydraulic transmissions in the following classes and states that combinations of the four classes may be made in an infinite number of ways.

(1) Fixed gear-ratios that can be changed in a discontinuous or continuous manner at the will of the operator. An equivalent and very efficient example of the discontinuous type is the orthodox gearbox and clutch combination. Variable-stroke pumps and hydraulic motors, are examples of the continuous type

(2) Mechanism of the previous class in which the ratio is a function of the torque on the secondary. An equivalent is a primary crank through some elastic coupling. Another simple equivalent type uses a belt and variable pulley

(3) Mechanism in which the secondary torque is produced or controlled by centrifugal forces due to the speed of the primary. A simple type consists of variable pulley and governor. Certain ratchet types of transmission also fall into the same class

(4) Mechanisms in which torque is transmitted through loss of energy. The simplest example is a slipping clutch of the ordinary friction type or of the hydraulic type using the throttling of a liquid to waste energy

Gears in Class 4 are not rated as variable transmissions, owing to the fact that they function as absorbers of power and not merely as means for transmitting power.

(*Continued on p.* 26)

For Balloon Tires

The Prevailing Steel Wheels

Of all cars equipped with balloon tires, at the 1924 National Automobile Shows, more were on Tuarc and Disteel wheels than on all other makes of wheels combined.

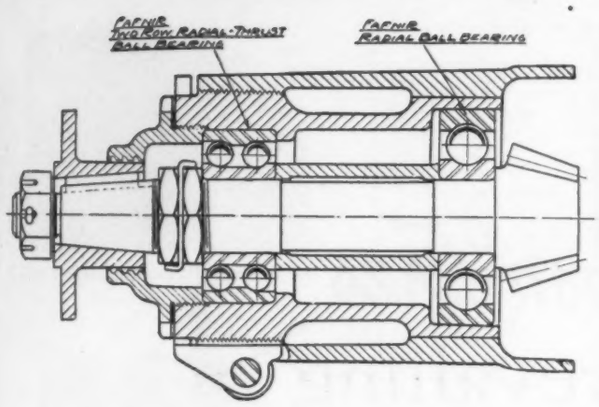
Motor Wheel Products are so clearly first in this new development, because Disteel was the very first steel wheel for balloon tires.

MOTOR WHEEL CORPORATION, Lansing, Mich.

Wood Wheels · *Steel Wheels* · *Stampings*

Disteel Tuarc

FAFNIR



The above cross section shows a typical installation of ball bearings for a passenger car pinion shaft.

The *Fafnir Single Row Radial Ball Bearing* is free to float endwise in the housing, with the result that the bearing carries radial load exclusively. It will be noted that a big bearing is used here since, due to the overhung pinion, the radial load is extra heavy.

The *Fafnir Double Row Radial-Thrust Ball Bearing* is restrained from end movement by a threaded lock nut, with the result that this bearing carries all of the end thrust load in addition to some radial load.

A feature of this installation is the threaded housing by means of which adjustment is to be had to bring the gears into correct alignment.

Our Engineering Department will be glad to co-operate with you in determining the best solution of your own problems.

THE FAFNIR BEARING COMPANY

New Britain, Conn.

CHICAGO, ILL. 537 South Dearborn St.
DETROIT, MICH. 120 Madison Ave., Room 511.
CLEVELAND, OHIO. 1016-1017 Swetland Bldg.
NEW YORK, N. Y. 5 Columbus Circle.
NEWARK, N. J. 271 Central Ave.
PHILADELPHIA, PA. 1427 Fairmont Ave.

NOTES AND REVIEWS

Continued

Items in Classes 2 and 3 and their various combinations are said to represent all that has been done and can be done with the means thus far considered as capable of obtaining automatic variable transmission, namely, springs or governors applied to mechanisms of Class 1.

In conclusion Mr. Constantinesco claims to have demonstrated the various devices discussed to be incapable of solving the problem of variable transmission.

In Part III of the paper, Mr. Constantinesco considers the features of his own mechanism which he calls a converter designed for transmitting power automatically from an internal-combustion engine or other prime-mover developing torque to a secondary shaft, the torque and the speed of the secondary being variable between very wide limits. To describe further the essentials of the mechanism, the following paragraphs are quoted:

> To obtain an increased torque on a driven shaft from a limited-torque prime-mover having a steadily rotating crank, a combination of oscillating, but non-revolvable, links and levers is utilized. These are connected to and receive negative and positive reactions due to the inertia of suitable masses oscillating or reciprocating about fixed mean positions. The levers and the links are also suitably connected to two unidirectional oscillating driving mechanisms converting such reactions into rotary impulses in one direction in such a manner that the frequency of the links, the levers and the mass is always equal to the number of complete revolutions of the crank of the prime-mover. The amplitude of the oscillation of the mass is variable and increases with an increase of the ratio between the speeds of the prime-mover and the driven shafts, and also decreases with a decrease of such ratio.
>
> A simple illustration of the principle of the converter is furnished in a floating lever, one end of which is caused to move by an eccentric mounted on a rotating shaft and which carries at its other end a mass. An intermediate point of the lever is attached to two connecting-rods, actuating a driven shaft through two unidirectional driving devices by which the oscillating movement of the floating lever is converted to a rotary movement, the unidirectionals operating at each half revolution of the driving shaft.
>
> With such an arrangement it will be seen that if the resistance to rotation of the driven shaft be small, the mass on the lever will not move far on each side of its mean position at each oscillation, and the length of travel of the unidirectionals will be a maximum when the resistance to rotation of the driven shaft is zero.
>
> As the resistance to rotation of the driven shaft increases, the travel of the mass increases, while that of the unidirectional decreases. Consequently at each revolution of the driving shaft, owing to the smaller angular movement of the unidirectionals when the resistance is high, the torque required from the prime-mover does not unduly increase, as will be shown later. With such an arrangement it follows that if, for example, the prime-mover be an internal-combustion engine, a constant or increased engine-speed can be maintained, although the torque on the driven shaft be considerably increased.
>
> Many modifications of the arrangement are evidently possible. To effect, however, the object of the invention, the driving shaft and the unidirectional driving connection should be attached to an oscillating or reciprocating member, such as a floating lever, at two different points, the lever carrying or being connected to a mass capable of oscillating or reciprocating about a mean position.

(*Continued on p.* 28)

A Good Gas Gage for the Dash

Electrically Operated—Reliable—Easy to Install

Officially Approved by Underwriters' Laboratories

The "R-K-D" Dash Gasoline Gage tells, *from the seat*, how much gas is in the tank—makes it as easy to read the gas in the tank as the miles on the speedometer.

Electrically operated. *Officially approved by Underwriters' Laboratories for Safety, Accuracy, Practicability, Durability and Uniformity.*

Takes any gasoline feed. Inexpensive. Easy to install.

No electric lights, glass tubes, liquids or sliding wires; no complicated, delicate or doubtful devices; nothing to get out of adjustment. No rattles.

The "R-K-D" consists of (1) meter for dash, (2) duplex armored cable extending from dash to tank, (3) special rheostat, operated by (4) thoroughly reliable float mechanism.

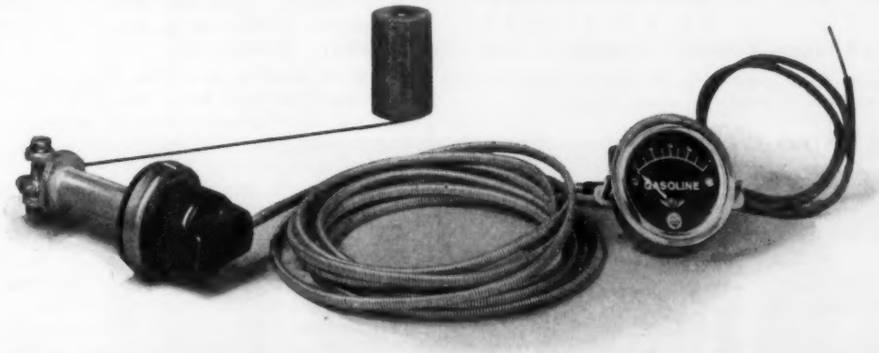
The "R-K-D" is a properly engineered job—sound and simple throughout.

The meter involves a new, balanced-coil principle, accurate and not affected by voltage variations. Installation in the line—no sub-assembly. Regular harness hook-up perfectly practicable if preferred to cable. Dials as per Car Manufacturers' Specifications.

The "R-K-D" Dash Gasoline Gage is in keeping with your demand for convenience and refinement in accessory equipment. It is a compliment to any instrument board.

We are ready to demonstrate this instrument at your convenience.

THE REITER-KING-DUGAN COMPANY, *Akron, Ohio*



Acme Wire

The slightly higher cost of Acme Wire is returned to you many times over in the increased output of winders, the fewer rejected coils, and the longer life of windings.

Acme Wire stands as the result of constant research and endeavor to produce the very best wire tha. can be made for one particular purpose — winding coils.

From the beginning of the magnet wire industry, Acme has pioneered in the development of fine silk-and-cotton-covered enamel wire.

Acme men know winding requirements through years of actual experience with winding conditions, for in our own plant they wind hundreds of thousands of coils each year.

THE ACME WIRE CO., New Haven, Conn.
NEW YORK CHICAGO CLEVELAND

"It goes in the space"

ACME WIRE PRODUCTS

"Enamelite," plain enameled Magnet Wire; "Cottonite," Cotton-covered Enamelite; "Silkenite," Silk-covered Enamelite; Single and Double Cotton Magnet Wire; Single and Double Silk Magnet Wire. We also have a complete organization for the winding of coils in large production quantities.

ACME VARNISHED INSULATIONS

Varnished Cambrics, Silks and Papers, Varnished Tapes in rolls; straight or bias. Varnished Tubing (Spaghetti).

ACME RADIO SPECIALTIES

Audio Transformer windings; Radio Frequency windings; Magnet windings for Head Sets; Enameled wire—especially the finest sizes, 40-44 B & S gauge; Silk and cotton-covered magnet wire; Enameled Aerial wire, single wire and stranded.

Illustrated Catalog on request to Engineers, Purchasing Agents, Executives, and Operators.

NOTES AND REVIEWS

Continued

The general description quoted above is followed by a mathematical analysis of the action of the mechanism under different conditions of operation. In considering the application of the converter to traction purposes the author lists the following main conditions that are essential when constant-torque engines are employed as prime-movers.

(1) Maximum torque and maximum number of revolutions of the engine are required to overcome wind and road resistance at the maximum speed of the vehicle. This means that the engine must be able to revolve up to the limit but not to exceed the speed for which it is designed under the full torque when the secondary speed is at the highest desired value

(2) In climbing the steepest gradient for which the vehicle is designed while the engine is developing its full torque; again the maximum safe number of revolutions for which the engine is designed must be maintained but not exceeded

(3) The engine under full torque shall under no circumstances reduce its speed of rotation below a given limit, corresponding to a poor performance either of the engine at that low speed or the vehicle in regard to its own speed of advance against the resistance encountered

(4) The vehicle shall be manageable either by maintaining the torque of the engine at any desired value, and for any desired time, from zero up to the maximum torque, or by maintaining the speed of the engine for any desired time at values between the minimum and the maximum for which it is designed

(5) The response to any variation in the torque and the speed of the primary or the secondary must be immediate and positive

Mr. Constantinesco promises to give a fuller discussion in a later article in which the converter will be analyzed from the automobile point of view.

VARIABLE TRANSMISSIONS, DISCUSSION. Published in *Automobile Engineer*, December, 1923, p. 393, and January, 1924, p. 20.

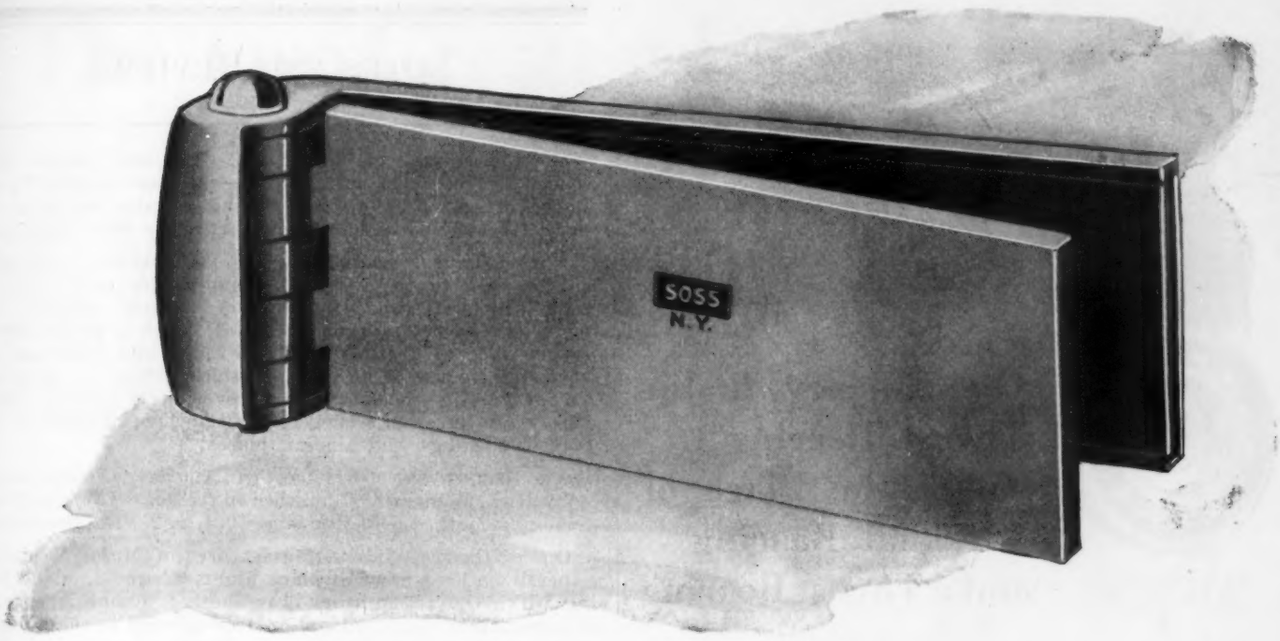
It appears that a number of people interested in variable transmissions are not in agreement with Mr. Constantinesco's mathematics and conclusions. Numerous points of difference are explained in letters written by D. S. de Lavaud, H. S. Hele-Shaw, R. H. Pearsall, A. F. Nash, J. L. Napier, W. S. Garton and the Pickett Construction Co. These letters merit very careful reading along with the paper itself.

Mr. Constantinesco replies to these criticisms, goes further with the mathematics involved and reviews several of the points previously brought out.

NEW METAL AIRPLANE FOR MAIL SERVICE. By Fred H. Colvin. Published in *American Machinist*, Jan. 24, 1924, p. 121. Illustrated.

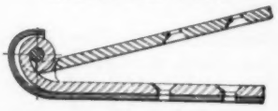
An airplane is described which was built especially for the Air Mail Service, being designed after a careful investigation of the characteristics of machines that would meet the requirements of the mail service. It is fitted with a high-compression 400-hp. Liberty engine. The speed varies from 116 m.p.h. to a slow landing-speed of 44 m.p.h. While loaded with 600 lb. of mail, it climbs 6800 ft. in 10 min., and has a ceiling, or maximum climb, of 16,200 ft. The wing span is 50 ft., the length 32 ft. 11 in., the height 12 ft. 9 in., and the wing area 540 sq. ft. The mail compartment has a capacity of 45 cu. ft. and will carry 1125 lb. of mail, but calculations have been made on the basis of 600 lb. of mail. Each of the two gasoline tanks, in the wings, holds 50 gal.,

(*Continued on p.* 30)



The New Covered-Joint Pressed Steel Hinge

Mechanical Accuracy with Low Cost



The shell and female section are welded together into a solid unit of strength and durability

PATENTED
December 28, 1920
December 11, 1923

No. 57 is furnished 1¾ inches wide in any length up to six inches. Hinge plates cut and holes drilled and countersunk according to your blue print.

This Soss Hinge Has Replaced the old style malleable on over a dozen of the leading production jobs in this country—

The No. 57, as it is called, is more accurate, stronger and lower in costs than the old style malleable.

Savings have been effected on some jobs that amounted to 75c on each body—Just calculate what this means to you on your estimated production for the year.

We are able through our extensive facilities to maintain definite production schedules and can make deliveries to meet requirements *on time.*

If you desire to mount these hinges on a sample job just drop us a line and we'll be glad to send you a sample set.

SOSS MANUFACTURING CO.
Incorporated
Grand Ave. and Bergen St., Brooklyn, N. Y.
Detroit Office, 535 Book Bldg.

SOSS

One Gurney Radio-Thrust Bearing Takes the Place of a Radial Bearing and a Thrust Bearing

THIS revolutionary practice was instituted by Gurney.

Formerly a radial bearing and its mounting was used to carry the full radial load, and a thrust bearing and its mounting to carry the full thrust load. Now a single R. T. Bearing in a single mounting carries the resultant load, which is always less than the sum of the radial and thrust loads.

Gurney engineers are experienced in solving difficult bearing problems. Call on them to help you with yours.

Gurney Ball Bearing Co.

402 Chandler St.

Jamestown, N. Y.

18220

GURNEY
BALL BEARINGS

NOTES AND REVIEWS

Continued

while the oil tank carries 12 gal. The total weight, fully loaded, is 4450 lb. A safety feature is a 3-gal tank of Pyrene under pressure; by merely opening a valve the pilot can spray the engine and extinguish any fire that may occur.

For structural reasons the fuselage takes a triangular section back of the wings. A plate-girder construction is used with beams or longerons of channel section. The material used is known as 17-S alloy, which is an aluminum-copper alloy of great strength. Frames and bulkheads are of metal from 1/32 to 1/16 in. thick, while the longerons are of 1/16-in. thickness. The covering is 1/32 in. thick. Heavy reinforcements of 1/16 in. metal are provided at the cockpit openings and similar places.

SOME RECENT DEVELOPMENTS IN AIRCRAFT INSTRUMENTS. By H. E. Wimperis. Published in the *Journal of the Royal Aeronautical Society*, January, 1924, p. 3. 14 illustrations.

One of the most interesting features of Major Wimperis' paper is an account of airplane flights around England during which the actual track was checked against the dead-reckoned track. The navigation accomplished in these flights served to show that present methods and instruments, when skillfully handled, are capable of making a splendid showing. In the past few years many of the dead-reckoning instruments have been changed and improved but little, but the compass is an exception. The aperiodic type has many merits and the new centesimal scale of Dr. Bennett has added to its usefulness.

The author discusses instruments and methods for (*a*) navigation by dead reckoning and (*b*) navigation by astronomical means. He devotes considerable space to compasses and their errors. Various powerplant instruments are also considered.

Several very interesting contributions from leaders in the field of aeronautics are included in the discussion of Major Wimperis' paper.

MATERIALS IN AIRCRAFT CONSTRUCTION. By Leslie Aitchison. Published in *Engineering*, Jan. 18, 1924, p. 89. 3 figures, 11 tables.

Only the metallic materials of aircraft construction are considered in this article, comprising mainly: mild-steel sheets, medium carbon-steel, cold-drawn steel, medium-tensile steel bar, high-tensile cold-worked steel, duralumin, aluminum, soft aluminum and light-alloy castings. An inquiry is made in regard to the properties that contribute toward the strength of these materials, observing in what ways and to what extent these properties are affected by the other qualities of the materials, as manufactured and as treated by the aeronautic constructor. The properties discussed are maximum stress, elastic-limit, proof stress and the fatigue strength, all of which, it is stated, need to be accompanied by a high ductility and as great a toughness as possible. It is shown that a metal having a high degree of strength otherwise might be unsatisfactory because of inadequate ductility, thus illustrating the apparent paradox, "the stronger the material, the weaker the part."

Imperfections of metallic materials considered in this paper are non-metallic inclusions such as slag, roaks and construction cavities, corrosion and internal stress.

The question is raised as to how the defects may be rendered most ineffective. It is recommended that a material shall be used only in that state in which it possesses the most satisfactory combination of maximum stress and ductility, inasmuch as high maximum stress in the absence of adequate ductility does not constitute strength but weakness. The beneficial effects of reheating hardened metals to suitable temperatures are emphasized, the suitability of temperature depending upon the nature of the metal, the type and

(*Continued on p. 32*)

The Two Greatest Improvements In Piston Ring Design—

Patented
March 20, 1910
May 2, 1922

the individually cast ring—

the oil-regulating principle

BOTH were originated by the makers of PERFECT CIRCLE Piston Rings—the individually cast ring, sixteen years ago; the oil-regulating principle—as incorporated in PERFECT CIRCLE *Oil-Regulating* rings—two and one-half years ago.

The PERFECT CIRCLE *Oil-Regulating* ring is not a temporary cure. It is a scientific engineering development—so recognized by Packard, Hupmobile, Marmon, Willys-Knight, and forty-four other leading manufacturers who use it as standard equipment. It enables you to use a low-tension ring, and at the same time to positively control oil.

[No scraping action to destroy lubrication—no edge pressure—positive regulation, under all conditions.]

Indiana Piston Ring Company, Hagerstown, Indiana
Harkrader & Harkrader: *Western Sales Agents*
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PERFECT CIRCLE
Oil-Regulating Piston Rings

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Modern improved highways are machine built. Labor saving devices of different kinds are used exclusively; but whatever type of road and the method of building, chief dependence must be put on the dump truck.

WOOD UNDERBODY HYDRAULIC HOISTS

The Hydraulic Hoist, developed by Gar Wood first made the dump truck practicable; and today Wood-Detroit Hydraulic Hoists still represent the highest degree of dependability, sturdiness and economy in this field.

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NOTES AND REVIEWS

Continued

the degree of hardening and the purpose to which the part is to be put. It is claimed that, besides its direct effect upon the toughness and ductility of a metal, reheating has decidedly beneficial effects upon the elastic-limit, proof stress, fatigue range and freedom from internal stress.

ARE BALLOON TIRES COMING TO STAY AND WHAT WILL THEY DO TO OUR CARS? By J. Howard Pile. Published in *Motor World*, Jan. 31, 1924, p. 20. Illustrated.

Defining the balloon tire as a large-section thin-wall tire for passenger-car use, designed to be operated at a low air-pressure, the author calls attention to the fact that it is not to be confused with the giant pneumatic tire that has been used for some time on trucks and passenger buses.

The semi-balloon type, having six plies instead of four, is mentioned, the caution being given against operating tires of this type at the low pressures recommended for balloon tires.

It is stated that the correct inflation-pressures for balloon tires have not as yet been fully determined and that when such determination is made the pressures will have to be more rigidly adhered to than has been the practice in the case of standard-size tires. This closer observance of the recommended tire-pressure is expected to produce an effect upon the accuracy of tire gages.

Several effects, such as side-sway, galloping and shimmying, noticeable with balloon tires at high speeds, are mentioned and described, and remedies are discussed. Centrifugal distortion as an element in balloon tire operation receives attention.

Other topics discussed include wheel and rim equipment, fitting balloon tires on present cars, increasing the tread, the price of balloon tires and the length of life.

1923 A MOMENTOUS YEAR IN BODY ENGINEERING. By Kingston Forbes. Published in *Motor Vehicle Monthly*, January, 1924, p. 12.

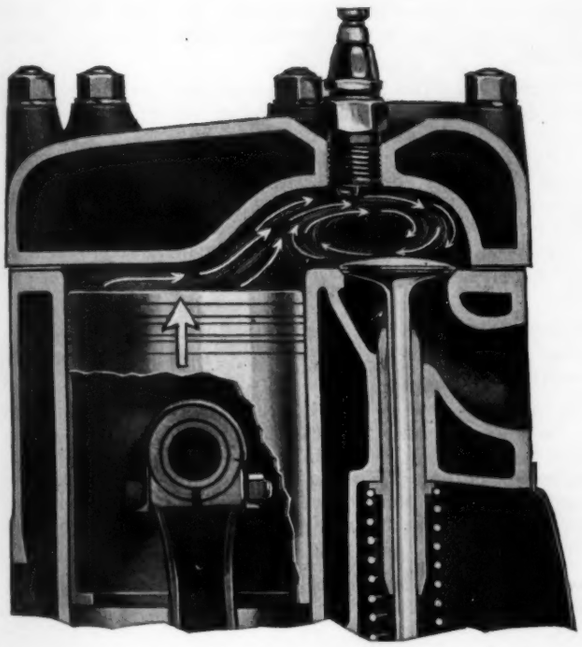
The author discusses recent developments in body designs, stating that the changes apparently indicate future trend. The following excerpts from the article will give an idea of the nature of these developments:

> The outstanding feature of the year has been the tendency to use the so-called straight-line bodies. For several years there has been a see-sawing back and forth between the rounded type of body and the sharp lines. Up to the year just ended the rounded type of body has predominated, but now the trend is all the other way.
>
> Not only has the sharp-line body gained in popularity, but the use of moldings has increased. The next striking development of the year has been the increased use of colors in painting production cars. Striping, which adds materially to the car's appearance, is employed very extensively, and when there is a molding on the body it is picked out and colored to emphasize the body lines.
>
> One striking innovation on the bodies has been the use of flush-type doors on the large-production cars of medium price.
>
> A feature of the 1923-24 closed-body design is the narrowing of the front post of the windshield frame to give better vision to the driver.
>
> The passing of each year sees the increased use of closed bodies, and with body-builders' increased production the closed body is becoming the universal type. They are fitted to every type of chassis, and the large production of some of the companies enables them to make the price of closed cars very low.

(*Concluded on page* 34)

The Ricardo Head

Turbulence accelerates combustion just as the wind fans the flames



United States Patent Granted Nov. 13, 1923 to Waukesha Motor Company as Assignee of Harry Ralph Ricardo, the English Scientist

By increasing the swirl of a more compact gas charge so that it is in a state of high turbulence at the instant of firing, and permitting a more favorable spark location in the combustion chamber, the Ricardo Head produces such promptness and completeness in charge-burning that the power output produced and the economy effected is greater than is obtained from standard types of engines.

Moreover, Ricardo Ell Head engines are purchasable at a relatively lower first cost, and have the further advantage of ability to outperform other types over a wide range of speeds and loads at less expense.

Ricardo Ell Head engines acquire the utmost consideration of those who seek to obtain more for the motor-purchase-dollar.

All Waukesha Motors are now equipped with the Ricardo Head.

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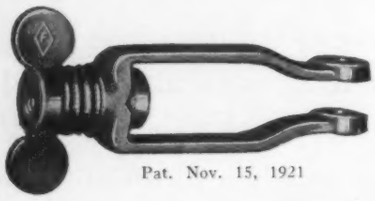
Because we specialize in:

Brake Rod Assemblies
Yoke Ends
Spring Clips
Levers
Shackle Links

and our



Pat. Nov. 15, 1921

"the keystone of equalized brake adjustment."

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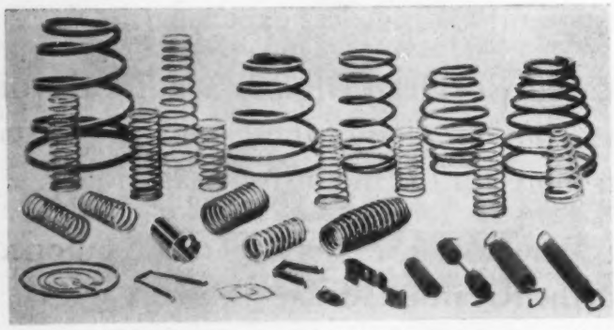
SPRINGS



Few realize, even among engineers, how much of engineering design, proper calculation of stresses, metallographic selection of materials, and scientific heat treatment, is involved in the production of a high grade spring—

We realize all these things—AND DO THEM.

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Manufacturers of All Types of Springs
Compression—Extension—Flat—Torsion

Any Size Any Material

Send for our treatise on springs.

NOTES AND REVIEWS

Concluded

MOTOR-VEHICLE BUILDERS GIVE INCREASED ATTENTION TO AIR-CLEANERS. By W. L. Carver. Published in *Automotive Industries*, Jan. 24, 1924, p. 180.

The troubles caused by dirt in the engine and the extent to which air-cleaners may eliminate these troubles are discussed. Attention is given to the reducing of service costs by the use of air-cleaners. Four different types that are marketed for car, truck and motorbus use are mentioned and their operation explained.

CONSTRUCTING AUTOMOBILE RADIATORS. By Charles O. Herb. Published in *Machinery*, February, 1924, p. 454. 13 illustrations.

The subject of this article is a radiator core constructed of flat brass fins and vertical tubes of elongated cross-section. After the fins and the tubes have been assembled, the core is dipped into a bath of molten metal to solder them at all joints, covering their entire surfaces with a thin coating of the solder and thus obtaining a sturdy construction. The upper and lower tanks are then soldered to the core, and the radiator tested to make sure that it is water-tight. The operations outlined above are described in detail.

AUTOMOBILE SHEET-STEEL SPECIFICATIONS. By H. M. Williams. Published in *Forging-Stamping-Heat Treating*, January, 1924, p. 24.

This paper covers in detail salient factors in connection with the chemical and physical qualities of sheet steel for automotive and other industrial purposes. A tentative specification for automobile sheet steel, offered as a basis for discussion and criticism, covers the following items: process, chemical composition, tempers, finish, permissible variations and packing.

FERROALLOY DEVELOPMENTS IN THE PAST YEAR. By Robert J. Anderson. Published in *The Iron Age*, Jan. 3, 1924, p. 94.

In addition to reviewing the markets and the trade situation for ferroalloys, this article shows that a large amount of experimental work has been going on in the development of methods for the production of better grades of ferroalloys and in the development of special alloy-steels. The portion of the paper dealing with stainless products states that interest in so-called stainless steels, about 12-per cent chromium alloys with iron, continues unabated, and that the production of these steels has increased the demands for chromite and ferrochromium. A British firm has made stainless steel tubing 15 ft. long and 3 in. in diameter, and it is reported that stainless iron is being made in Sweden at the cost of mild steel. New developments of much interest are chromium plating and chromizing. Chromizing is done by diffusing chromium, by heating, into iron and steel, yielding a surface layer of the chromium-iron alloy. In the process, the material to be treated is packed in a mixture of 45 per cent of alumina and 55 per cent of chromium powder, and then heated at 1300 to 1400 deg. cent. (2372 to 2552 deg. fahr.) in hydrogen, vacuum or neutral atmosphere. The process is analogous to calorizing.

Chromized steel is good for resisting corrosion, but it has two competitors, chromium plating and stainless steels. Chromium plating has not been applied much commercially, although the possible applications are numerous. It is stated that the best results in chromium plating are secured with 13.40 amp. per sq. dm. (134.49 amp. per sq. ft.) and a solution of 3 grams per liter (0.4 oz. per gal.) of chromium sulphate and 245 grams per liter (29.43 oz. per gal.) of chromic acid, chromium anodes being used. A bibliography on stainless steel has been published by the Carnegie Library of Pittsburgh.

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The most efficient and permanent insulation known is

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The World's Largest Producer of
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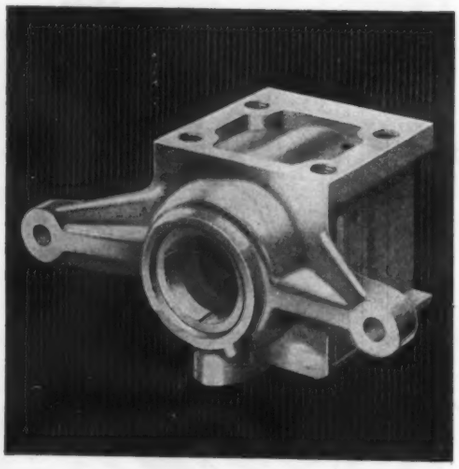

In checking up on the prices of a die-cast part, include among the items involved the cost of a possible failure of that part in the place where it will ultimately be used.

A very slight difference in the purchase price per part may cause a very large difference in the ability of that part to render the service expected.

Doehler engineers and metallurgists welcome every opportunity to work with machinery manufacturers in designing, as well as in producing, die-castings that will not disappoint.

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BROOKLYN. N.Y. TOLEDO. OHIO.
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Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

W. L. Adams resigned recently as president of the Advanced Motors Corporation, New Haven, Conn., and has organized the Adams Motors Corporation, also located at New Haven, of which he is president and chief engineer.

William K. Adler, who was formerly assistant electrical engineer for the International Harvester Co., Chicago, is now designer for the Western Electric Co., Hawthorne, Ill.

Leon L. Aitken has accepted a position as designer and checker of special machinery, tools, jigs and fixtures for the Chevrolet Motor Co. of Michigan, Flint. His previous connection was chief tool designer for the Fuller & Sons Mfg. Co., Kalamazoo, Mich.

Benjamin H. Anibal has been appointed consulting engineer for the Studebaker Corporation, Detroit.

F. G. Baender, who was formerly superintendent of plant and head of the research department of the Joseph W. Hays Corporation, Michigan City, Ind., has severed his connection with that organization. His plans for the future have not been announced.

Major Thurman H. Bane is now located in Monterey, Cal. He was recently retired from the position of chief engineer in the engineering division of the Air Service at McCook Field, Dayton, Ohio.

Joseph Berge has resigned as engineer for the A. C. Spark Plug Co., Flint, Mich., and has opened offices in the Smith Building, Flint, specializing in accessory design.

P. E. Biggar has severed his connection with the Packard Motor Car Co., Detroit, where he filled the position of tester. His plans for the future have not been announced.

W. I. Bowman is service manager for Bowman & Morse, Minneapolis, Minn. He was formerly associated with the Great Northern Railroad Co., St. Paul, in connection with air maintenance.

J. S. Bretz, vice-president of the Bearings Co. of America, Lancaster, Pa., has been appointed foreign sales representative of the Caspar Oil Corporation, New York City.

Garnet C. Brown, who was previously chief engineer in the automotive division of the United & Globe Rubber Co., Trenton, N. J., has been made sales engineer for the L. H. Gilmer Co., Philadelphia.

Ben Stalker Buckmaster has accepted a position as salesman for the Martin Varnish Co., Chicago. He was formerly district sales manager for the Better Tires Co., also of Chicago.

Fred J. Campbell, who was until recently chief draftsman for the Falls Motors Corporation, Sheboygan Falls, Wis., has become affiliated with the Kohler Co., also of that city.

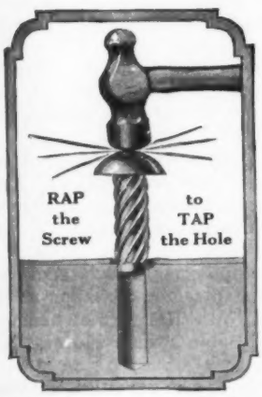
Kenneth A. Carmin has been appointed laboratory assistant of the Remy Electric Division of the General Motors Corporation, Anderson, Ind. He formerly attended Purdue University, Lafayette, Ind.

Harry R. Carr is no longer inspector and tester of electric trucks for the Ward Motor Vehicle Co., Mount Vernon, N. Y., but has become associated with Charles E. McInnes, Inc., Philadelphia, as transportation and sales engineer.

(*Continued on p. 4*)

A New and Better Means of Making Fastenings—

To Steel, Cast Iron, Brass and Aluminum, Bakelite, etc.



PARKER - KALON HARDENED METALLIC DRIVE SCREWS have made possible large savings of time and labor in attaching name plates and in making other permanent fastenings to steel, cast iron, brass and aluminum castings, bakelite, etc. More than 2500 manufacturers in the automotive, electrical and machinery fields—many of them the leading concerns in their line—have found that these Screws make better, quicker and cheaper fastenings than machine screws, escutcheon pins, rivets, etc.

Better because the fastenings made are permanent—vibration won't work them loose. *Quicker* because the tapping operation is completely eliminated—Hardened Metallic Drive Screws cut their own thread in the material as they are hammered in. *Cheaper* because the cost of the tapping is saved and less time is required to make the fastening—actual savings in many cases run as high as 75%.

Investigate the possibilities these Screws offer. See whether you can use them in your plant. It may result in substantial savings for you—and other advantages besides.

We'll gladly send you free samples and full information. The Screws are made in sizes ranging from .052 to .218 in diameter and in lengths from ⅛" to ¾". *Use the coupon.*

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(Pat. Jan. 29, 1924)

Greatly enlarged view shows the hardened steep spiral thread that cuts into the material as the screw is hammered in.

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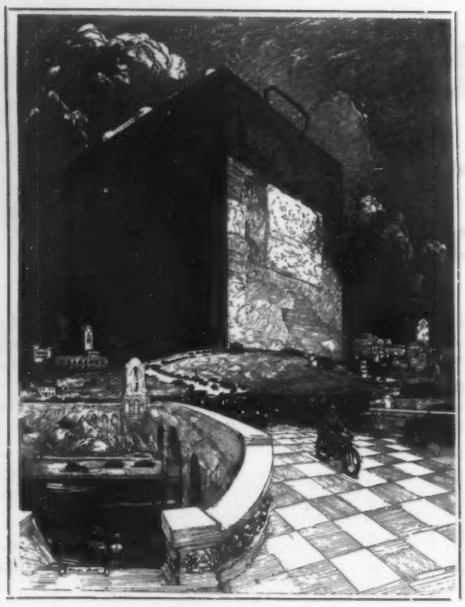

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Even if its record had not clearly demonstrated the fact, one would expect better battery performance from the Exide because of the experience of its makers—

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The world's largest manufacturers of storage batteries for every purpose.

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PERSONAL NOTES OF THE MEMBERS

Continued

Charles A. Chevraux has severed his connection with the Beans Spring Co., Massillon, Ohio, where he held the office of secretary. His plans for the future have not been announced.

Emerson L. Clark, who was formerly designing engineer for the Glenn L. Martin Co., Cleveland, has been made chief engineer of the National Electric Mfg. Co., Pittsburgh.

Menefee R. Clements has accepted a position as mechanical engineer with the Gernandt Motor Corporation, South Bend, Ind. He was previously associated with the Studebaker Corporation of America, also of South Bend, in a similar capacity.

David J. Conant has been appointed chief engineer for the Western Well Works, Inc., San Jose, Cal.

W. M. Corse, who was formerly chairman of the division of research extension of the National Research Council, City of Washington, has been appointed consulting metallurgist for the International Nickel Co., New York City.

John C. Dayton, who until recently was traveling expert on engines, tractors and trucks for the International Harvester Co., Chicago, has been made mechanic in charge of motor trucks for the Harrisburg Coca Cola Bottling Works, Harrisburg, Pa.

Arthur B. Domonoske has been appointed associate professor of experimental engineering and director of shops at the University of California, Berkeley, Cal. His former business connection was chief engineer for Doble Steam Motors, San Francisco.

George H. Ellinwood is in charge of the technical division of the Boston Belting Co., Boston. Previous to this he was technical superintendent of the Federal Rubber Co., Cudahy, Wis.

Ernest A. Elliott has accepted a position as designer for the Chevrolet Motor Co., Detroit.

Edwin D. Emmons has been appointed representative for the Bridgeport Coach Lace Co., Bridgeport, Conn., with headquarters in the General Motors Building, Detroit. He was formerly sales manager for the Hayes Mfg. Co., Detroit, and also associated with the Hayes Ionia Co., Grand Rapids, Mich.

Benjamin M. Engesser has become affiliated with the Allis-Chalmers Mfg. Co., Milwaukee, Wis., in its erection division and is engaged in work on turbo-generators.

G. M. Evans, who was until recently superintendent of planning for the Maxwell Motor Corporation, Detroit, has been appointed assistant to the president of the Edward G. Budd Mfg. Co., Philadelphia.

Martiniano Floro has severed his connection with the Frick Co., Waynesboro, Pa., where he was engaged in mechanical engineering work, and has gone to Manilla, P. I.

F. Leslie Ford is no longer chief draftsman for the Cooley & Marvin Co., Boston, but has become architectural draftsman for Ritchie, Parsons & Taylor, also of Boston.

Albert A. Forster, who was formerly associated with the Splitdorf Electrical Co., Newark, N. J., in connection with time study and production engineering, is now engaged in production engineering for the Wright Aeronautical Corporation, Paterson, N. J.

Charles W. Frederick has accepted a position in the experimental laboratory of the General Motors Corporation, Detroit. He was until recently employed in the experimental engineering department of Dodge Bros., also of Detroit.

Donat A. Gauthier, who has been assistant mechanical superintendent at the Ottawa Car Mfg. Co., Ottawa, Ont., is now a student at the McGill University, Montreal, Que.

Harry Gerdes has accepted a position as mechanic for the Salt River Valley Water Users Association, Phoenix, Ariz. He was previously instructor in automobile mechanics in the El Paso Public Schools, El Paso, Tex.

Charles H. Gleason, who was until recently sales manager for the Maremont Mfg. Co., Chicago, has been appointed general manager for the American Motor Safety Corporation, Kalamazoo, Mich.

(*Continued on p. 6*)

Would You Buy Piston Rings Without a Name

Of course you wouldn't—and yet what difference does a name make unless it is a guarantee of everything you require of piston rings for more power, a saving in gas consumption, greater resiliency, and a smoother running engine?

For there is as much difference in piston rings as there is difference in the experience, knowledge and manufacturing facilities of piston ring makers.

The 125,000,000 **QUALITY** Piston Rings that have been put to work during the past 12 years, have through continued performance made **QUALITY** Rings the recognized standard for initial installation.

The Piston Ring Company

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The tradename **QUALITY** which is stamped in each ring, was selected as the only word suitable to fully express the actual values in each ring that bears this name.

"NORMA"
PRECISION
BALL BEARINGS

For Lighting Generators
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As grows the number of cars and trucks in use, so grows recognition of the importance of dependable electrical equipment. And—

From year to year grows the demand for "NORMA" Precision Bearings for high-grade magnetos and lighting generators. For the simple reason that—

Service records prove that magnetos and lighting generators with "NORMA" Precision Bearings run more quietly, last longer.

A booklet will be sent on request. And our engineers will welcome an opportunity to work with yours.

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BALL, ROLLER AND THRUST BEARINGS

PERSONAL NOTES OF THE MEMBERS

Continued

Edwin J. Godbold has severed his connection with the Climax Engineering Co., Clinton, Iowa, and is now designing engineer for the Reynolds Engineering Co., Rock Island, Ill.

George E. Goddard, whose name has long been associated with engineering work at Dodge Bros., Detroit, has resigned his position of assistant chief engineer. No announcement has been made of his future plans.

Carl F. Goudy has accepted a position as works manager of the Pacent Electric Co., New York City. He was formerly assistant instructor in the mechanical laboratory of Pratt Institute, Brooklyn, N. Y.

John Grabner is now affiliated with Dodge Bros., Detroit, as a draftsman. Until recently he held a similar position with the Continental Motors Corporation, also of Detroit.

Edward W. Griffith has joined the sales department of the Wire Wheel Corporation of America, Buffalo. He was previously sales manager of the Forsyth Bros. Co., Harvey, Ill., one of the Motor Wheel Corporation units.

Louis B. Hall has accepted a position as designing engineer for the Otis Elevator Co., New York City. He was formerly working on rail car design for the International Motor Co., also located at New York City.

Howard B. Haskins, who was until recently engineer for the Gray Motor Corporation, Detroit, is now body engineer for the Towson Body Co., also of Detroit.

John W. Hertzler has been made manager of the worm gear department of the DeLaval Steam Turbine Co., Trenton, N. J. He was previously president and general manager of the Cleveland Worm & Gear Co., Cleveland.

Merton O. Hodgkins has organized the Aviation Service Co., Detroit. His former business connection was with the Commercial Engineering Laboratories, also of Detroit.

Fenn M. Holden has joined the advisory staff in the engineering and research section of the General Motors Corporation, Detroit.

H. J. Howatt, who was previously technical engineer with the Jordan Motor Car Co., Cleveland, has accepted a position with the Studebaker Corporation of America, South Bend, Ind.

Edward Hughes has been made assistant general manager for the Michigan Copper & Brass Co., Detroit. Until recently he was master mechanic for the Dayton Engineering Laboratories Co., Dayton, Ohio.

Frank E. H. Johnson has severed his connection with the British & American Motors, Ltd., Toronto, Ont., where he was works manager. No announcement has been made of his future plans.

Homer E. Johnson has organized the Johnson Electric Co., Orange, N. J. He was formerly assistant engineer for the Simms Magneto Co., East Orange, N. J.

Ralph S. Kellogg is no longer a layout draftsman with the A. C. Spark Plug Co., Flint, Mich., but has a similar position with the Packard Motor Car Co., Detroit, in the engineering department.

Louis T. Knocke has accepted a position with Dodge Bros., Detroit.

A. Kurti has become sales engineer for the Timken Roller Bearing Co., Canton, Ohio.

C. H. Landon, who was formerly chief engineer for the American Bronze Corporation, Berwyn, Pa., has accepted a position as mechanical engineer with the Philadelphia Bronze Bearing & Tube Co., Philadelphia.

John D. Lannon has been appointed assistant to the general manager of manufacturing of the American Radiator Co., Buffalo. He was previously general superintendent of the Oakland Motor Car Co., Pontiac, Mich.

James R. Longwell is now affiliated with the American-LaFrance Fire Engine Co., Elmira, N. Y., in charge of stock control.

(*Continued on p.* 8)

The valve with a heritage

THOMPSON Silcrome Valves are the greatest and the most rugged development of a line that has lead since the first days of the "horseless carriage." From millions of fine alloy valves they inherit all the integrity, skill and experience that pioneer valve-builders can put into a product.

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THOMPSON SILCROME VALVES

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Also manufacturers of king bolts, shackle bolts, tie rod bolts, drag links, starting cranks, and brake rod assemblies

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Self-Aligning ROLLER BEARING
PAT. & PATS. PENDING
Shafer Roller Bearings are fulfilling the demand for a self-aligning roller bearing that will efficiently carry all combinations of thrust and radial loads, applied from any angle.
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PERSONAL NOTES OF THE MEMBERS

Continued

Ralph H. McAllister, who was formerly a draftsman in the engineering department of the American Rolling Mill Co., Ashland, Ky., has accepted a position with the Philadelphia & Reading Coal & Iron Co., Pottsville, Pa.

Robert F. McCann is no longer a partner in the Dayton Automobile Sales Co., Dayton, Ohio, but has become sales manager for the Refiners Oil Co., also of Dayton.

Harry S. McClellan has become affiliated with the Maxwell Motors, Inc., Detroit, as general superintendent. He was previously superintendent of Plant No. 1 of the Buick Motor Co., Flint, Mich.

Raymond L. McFarland has been appointed electric service representative of the American Bosch Magneto Corporation, Springfield, Mass. Prior to this he was manager of the electric service-station of the Wappelo Battery & Electric Co., Ottumwa, Iowa.

Mitchell Mackie has been elected president of the Mitchell Mackie Co., Milwaukee.

Clarence W. Miller has been appointed general manager of the Steel Products Co., Cleveland.

Raymund V. Morris, who was formerly vice-president and general manager of the Spreckels "Savage" Tire Co., San Diego, Cal., is now president and manager for Raymund V. Morris, Inc., also of San Diego.

Bruce G. Mortimer is now service manager for the S. M. Byers Motor Corporation, Washington, Pa. He was previously shop foreman for the Toronto Durant Co., Toronto, Ont.

F. E. Moskovics was elected vice-president of the Franklin Automobile Co., Syracuse, N. Y., at a recent meeting of the board of directors. As mentioned in the January issue of THE JOURNAL, Mr. Moskovics was vice-president of the Nordyke & Marmon Co., Indianapolis, for 10 years, and later engaged in industrial engineering work. He retains his position as receiver for the Stevenson Gear Co., Indianapolis.

Millard H. Newton, who was until recently advertising manager for the White Co., Cleveland, has become affiliated with the Cleveland office of the McGraw-Hill Co., New York City.

W. W. Noble is now district sales manager of the Pittsburgh Crucible Steel Co., Pittsburgh, with headquarters in New York City.

Lee W. Oldfield has opened an office in the Conway Building, Chicago, as a consulting engineer. He was prior to this research engineer for the Motor Efficiency Co., Indianapolis.

Gust Olson, Jr., who was formerly sales engineer for the Yellow Sleeve Valve Engine Works, Inc., East Moline, Ill., is now in charge of sales in the Tri-City, Iowa and Nebraska districts for the E. L. Essley Machinery Co., Chicago.

Joseph A. Packard has been appointed research engineer for the Michigan State Highway Department, Lansing, Mich.

George H. Palm has become engineer for the Yellow Coach Mfg. Co., Chicago. Previous to this he was chief draftsman for B. S. Pfeiffer, also of Chicago.

Emil Panek is no longer engineer for the Globe Machine & Stamping Co., Cleveland, but has been made engineer in the metal stamping division of the Loew Mfg. Co., also of Cleveland.

Parry H. Paul has become associated with the International Motor Co., Plainfield, N. J.

Austin E. Potter is now general manager of the Rotor Pump Works, Brooklyn, N. Y.

W. E. Powell, who was formerly manager of the service department of the More Automobile Co., St. Louis, has been made production manager for the Dayton Fan & Motor Co., Dayton, Ohio.

Charles S. Price has been appointed research engineer for L. F. Grammes & Sons, Inc., Allentown, Pa. He was until recently chief engineer for the Bethlehem Spark Plug Co., Bethlehem, Pa.

(*Continued on p.* 10)

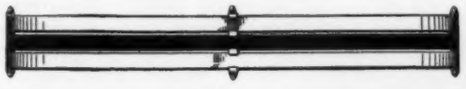
ORIGINALITY

In a recent decision of the United States Court of Appeals, Sixth Circuit, involving litigation between two bumper manufacturers other than ourselves, the following appears:

> "But, if these two patents be disregarded as not pertinent, McGregor, 908025 (1908), discloses a double bar bumper made of tubular bars vertically spaced, thereby *enlarging the impact surface*, not only in the central part, but for *the entire width of the car*."

In 1921 we purchased the McGregor patents, including the one mentioned above. We hope to continue in our bumper design the same foresight shown by Mr. McGregor in 1908.

We introduced the parallel bar bumper, now in almost universal demand.



This "demand" now requires us to produce several thousand "Parabar" Bumpers per day.

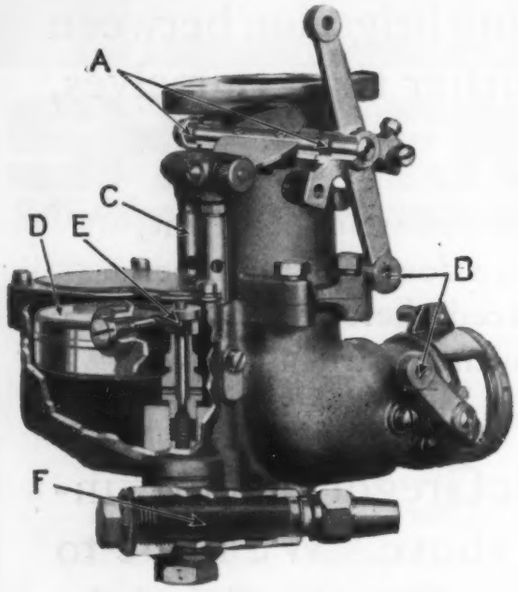
Christian Girl
President

THE C. G. SPRING & BUMPER CO., DETROIT
NEW YORK CLEVELAND KALAMAZOO CHICAGO

(11)

Specially Designed for Hardest Service

The new Zenith UF Carburetor is the only carburetor constructed throughout to meet the heavy duty requirements of commercial service—for buses, cabs, trucks and tractors. It adds to the economy of operation which has made Zenith dominant in this field—an economy of maintenance possessed by no other carburetor.



ZENITH CARBURETOR

Easy Starting is assured by the special starting well (C) which furnishes a reserve of gasoline for this purpose, and by the felt washers, under compression (A) preventing leakage of air by the throttle shaft.

Sturdiness is increased by making the levers (B) heavier.

Longer Life is made possible by making all parts liable to wear easily and inexpensively renewable. For instance, the throttle shaft is fitted with renewable bronze bushings.

Wear Is Prevented in the float mechanism — the most troublesome part of the ordinary carburetor in commercial service—by preventing the "spinning" of the float and needle valve as the result of vibration. An improved design simplifies the whole mechanism, makes cleaning and inspection easier and makes spinning impossible (E).

Greater Convenience is given by the improved screen (F). It is larger and it can be removed without disturbing the gasoline line.

Let us tell you more about this better carburetor; just ask about the Zenith UF.

ZENITH-DETROIT CORPORATION

Manufacturer of

ZENITH CARBURETORS

DETROIT MICHIGAN

Branches:

NEW YORK • CLEVELAND • CHICAGO

Service Stations in over 800 cities

PERSONAL NOTES OF THE MEMBERS

Continued

Karl F. Ranger has become affiliated with the tool engineering division of the Chrysler plant of the Maxwell Motor Corporation, Detroit. His previous business connection was with the Cadillac Motor Car Co., also of Detroit.

Herman B. Ring has been made manager of the Lawrance Division of the Wright Aeronautical Corporation, Paterson, N. J. He was until recently general manager of the Lawrance Aero-Engine Corporation, New York City.

Edward V. Rippingille, who was formerly president of the Watson Stabilator Co. of Detroit, and **Vernon G. Souder**, who was treasurer of that company, have formed a partnership and are doing business under the name of Rippingille & Souder, with offices in the General Motors Building, Detroit.

Hugh A. Robinson has accepted a position as chief engineer for the Hubbard Rotary Reversible Motor Co., Wichita Falls, Tex. He was previous to this general superintendent and engineer for the Aeromarine Plane & Motor Co., Keyport, N. J.

Edward W. Rounds is no longer associated with the Naval Aircraft Factory, Navy Yard, Philadelphia, but has become aeronautical engineer for the Wright Aeronautical Corporation, Paterson, N. J.

William C. Rowles has been appointed sales engineer for the Blodgett Engineering & Tool Co., Detroit.

Harry M. Rugg has severed his connection with Dodge Bros., Detroit, where he was engineer in connection with the dynamometer and laboratory experimental departments. No announcement has been made of his future plans.

R. S. Russell has severed his connection with the Roamer Motor Car Co., Kalamazoo, Mich., where he was engineer. His plans for the future have not been announced.

Louis Ruthenburg, who was formerly president of the Associated Motor Industries, Dayton, Ohio, has been made general manager of the Yellow Sleeve Valve Engine Works, Inc., East Moline, Ill.

William D. Sargent has been elected president of the Eastern Steel Castings Co., Newark, N. J.

Elias N. Sawyer, who was until recently general superintendent of the Cleveland Tractor Co., Cleveland, has been made works manager for the Rollin Motor Co., also located at Cleveland.

Francis J. Scarr has been appointed representative of automotive transportation engineering on Operating Committee B for the Eastern Region of the Association of Railway Executives, 143 Liberty Street, New York City. He was formerly transportation engineer for the Motor Haulage Co., also of New York City.

G. C. Sedley-Brown, who was previously president and general manager of the White Plains Stratton-Bliss Co., White Plains, N. Y., has been appointed field representative for Dodge Bros.

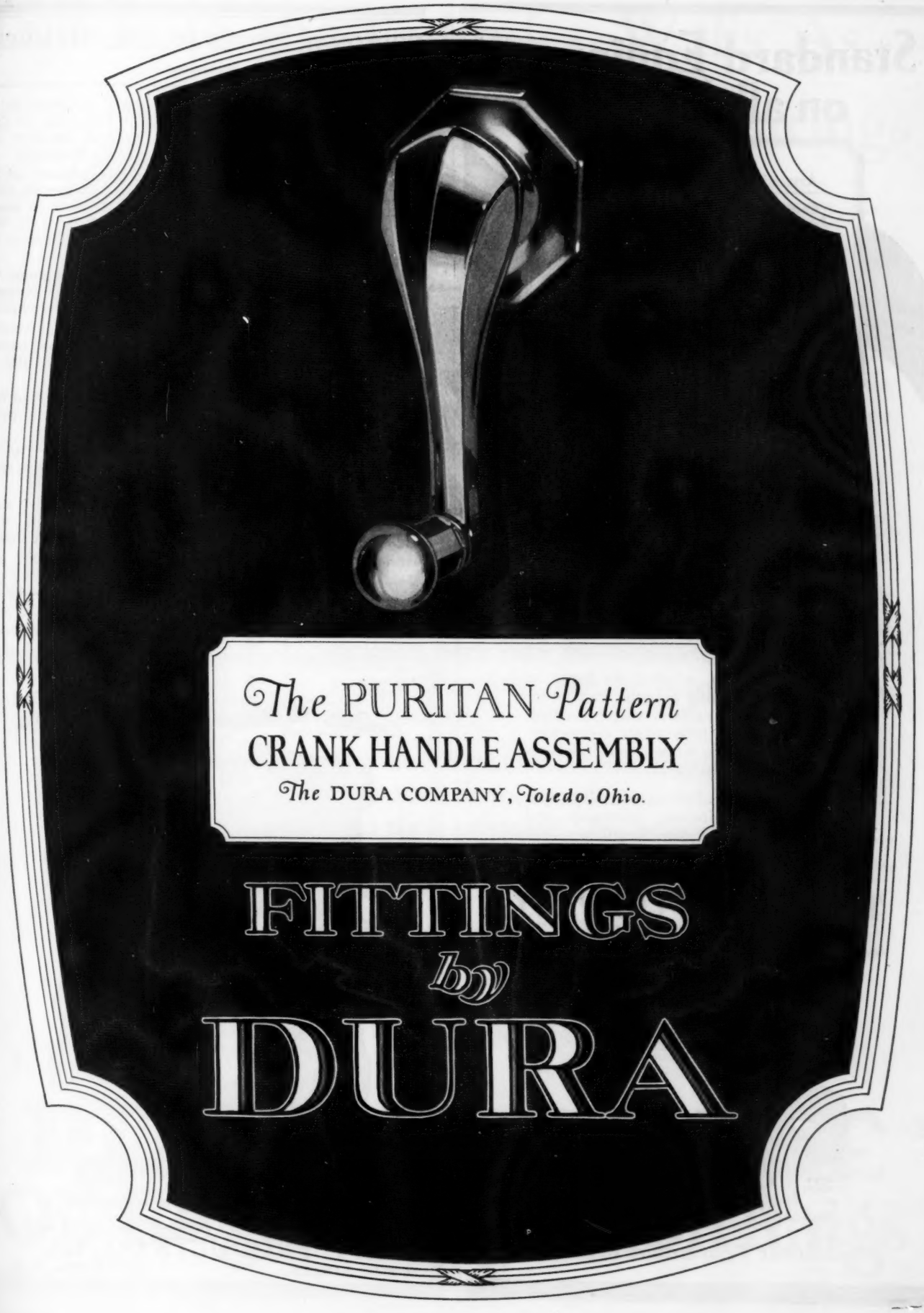
Lon R. Smith has been elected president of the Columbia Motors Co., Detroit, succeeding **J. G. Bayerline**, who has retired. Mr. Smith was formerly vice-president of the Mid-West Engine Co., Indianapolis, and more recently president of Smith & Wilson, Inc., also of that city.

Herbert C. Snow has accepted a position as chief engineer for the Velie Motors Corporation, Moline, Ill. He formerly held a similar position with the R. H. Long Co., Framingham, Mass.

Howard L. Spohn has become affiliated with the Gardner Advertising Co., St. Louis, and will be directing head of its Chicago office. Prior to this he was vice-president of the Charles H. Fuller Co., Chicago.

Frank S. Spring, who was formerly chief engineer for the Courier Motors Corporation, Sandusky, Ohio, has been made service manager in charge of all branches for the Walter M. Murphy Co., Los Angeles.

(*Concluded on p.* 12)


The PURITAN Pattern
CRANK HANDLE ASSEMBLY
The DURA COMPANY, Toledo, Ohio.
FITTINGS
by
DURA

Standard Equipment on all these cars

American Cars	Foreign Cars
Cadillac	Fiat
Cunningham	Lanchester
Lafayette	Leyland
Lincoln	Napier
Packard	Rolls-Royce
Paige-Detroit	Straker-Squires
Pierce-Arrow	Vauxhall
Premier	

And many other Cars and Trucks

The Sylphon Automobile Temperature Regulator consists of three main parts; the Sylphon Bellows—that *seamless,* flexible, all-metal expansion member, which is the heart of all Sylphon products; a valve and a housing for the Sylphon.

The Sylphon is filled with a highly volatile liquid, which vaporizes at a predetermined temperature, expanding the Sylphon and opening the valve to admit water, and contracting and closing the valve when the temperature falls.

Is self-regulating, adapted to pump or thermo-syphon cooling systems, can be installed between the radiator and the engine, either in outlet or inlet water connection. Has no moving parts to wear out, needs no oiling and will outlast the motor.

Do not accept imitations or substitutes. We are the originators, patentees and manufacturers of Sylphon Regulators.

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120 Prince Street, Montreal, Canada

Automobile Temperature Regulator

PERSONAL NOTES OF THE MEMBERS

Concluded

Carleton E. Stryker has been appointed assistant to the professor of experimental engineering at University of California, Berkeley. Previous to this he was designer and draftsman for the Doble Steam Motors, San Francisco.

E. J. Tiedemann, assistant general superintendent of the body plants of the Maxwell Motor Corporation, Dayton, Ohio, in charge of manufacturing, resigned on March 1 to accept the position of assistant factory manager of the C. R. Wilson Body Co., Detroit, where he will have supervision of the production of bodies for that company.

Harry A. Trautman has been made research engineer for the Michigan Steel Casting Co., Detroit. He was formerly manager of production for the K-W Ignition Co., Cleveland.

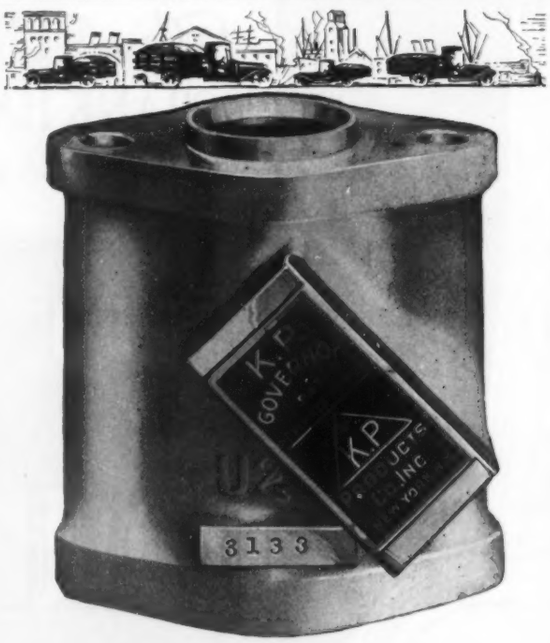
Everett W. Turley is no longer manager of the automobile service department of Wilson & Co., Chicago, but has become salesman for the Autocar Sales & Service Co., also of Chicago.

Edgar D. Upstill has been made treasurer of the Tool Service Co., Cleveland. Prior to this he was experimental tester for the White Motor Co., also located at Cleveland.

Andrew L. Vargha, who was formerly designer for the Harrison Radiator Co., Lockport, N. Y., has accepted a similar position with the Chevrolet Motor Co., Detroit.

George C. Warner has been appointed district sales manager for the George D. Whitcomb Co., Rochelle, Ill., with headquarters in Pittsburgh. Until recently he held a similar position with the Morgan-Gardner Electric Co., Chicago.

John G. Willet, who was previously associated with F. H. Sinclair, Buffalo, is engaged in general engineering work for the Sterling Engine Co., also of Buffalo.



K·P. Governor
GOVERNS WITHOUT LOSS OF POWER

Power curves and sample governor sent on request.
K. P. PRODUCTS CO., Inc.
50 PINE STREET, NEW YORK, N. Y.

Lubricate the Cylinder Walls As You Do Other Bearings

Patented
March 20, 1910
May 2, 1922

Maximum motor efficiency has always demanded that the cylinder walls be as thoroughly lubricated as every other bearing surface in order to minimize friction and increase power.

Yet, until the advent of the PERFECT CIRCLE *Oil-Regulating* ring, it was impossible to do this without creating another evil—excess oil consumption, and oil-pumping.

The exclusive PERFECT CIRCLE principle of oil-regulation has changed this. PERFECT CIRCLE *Oil-Regulating* rings insure ample lubrication. The groove on the face of this ring cannot be completely drained of oil. Yet all *surplus* oil is drained back into the crank-case through the slots in the ring, and the holes drilled in the ring groove.

PERFECT CIRCLE *Oil-Regulating* rings consistently give 1000 or more miles to the gallon of oil—and they *lubricate!* One reason why Packard, Hupmobile, Willys-Knight, Marmon and forty-five others use them as standard equipment. Write for samples and complete information about these rings.

INDIANA PISTON RING COMPANY
Hagerstown, Indiana

PERFECT CIRCLE
Oil-Regulating Piston Rings

©1924

"It goes in the space"

Acme Wire "goes in the space," smoothly, easily, without any kinks or bulges. The last turn does not have to be forced and hammered into place.

It goes in the space because it is uniform, free from lumps, bare spots, and other imperfections. Its insulation is smooth, even, and of high dielectric strength.

Back of Acme Wire is a company that has pioneered in the development of fine silk- and cotton-covered enamel wire since the beginning of the magnet wire industry.

Back of it, too, are years of investigation and research in developing wire that exactly meets winding conditions. Acme knows these conditions thoroughly, for in our own plant hundreds of thousands of coils are wound each year.

The slightly higher cost of Acme Wire is returned many times over in the increased output of winders, the fewer rejected coils, and the longer life of windings.

THE ACME WIRE CO., New Haven, Conn.
NEW YORK CHICAGO CLEVELAND

Acme Wire

ACME WIRE PRODUCTS

"Enamelite," plain enameled Magnet Wire; "Cottonite," Cotton-covered Enamelite; "Silkenite," Silk-covered Enamelite; Single and Double Cotton Magnet Wire; Single and Double Silk Magnet Wire. We also have a complete organization for the winding of coils in large production quantities.

ACME VARNISHED INSULATIONS

Varnished Cambrics, Silks and Papers, Varnished Tapes in rolls; straight or bias. Varnished Tubing (Spaghetti).

ACME RADIO SPECIALTIES

Audio Transformer windings; Radio Frequency windings; Magnet windings for Head Sets; Enameled wire—especially the finest sizes, 40-44 B & S gauge; Silk and cotton-covered magnet wire; Enameled Aerial wire, single wire and stranded.

Illustrated Catalog on request to Engineers, Purchasing Agents, Executives, and Operators.

Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

THE THERMODYNAMICS OF AIRCRAFT ENGINES. By H. R. Ricardo. Published in *The Journal of the Royal Aeronautical Society*, February, 1924, p. 49. 17 illustrations.

In this paper, the purpose of which is to outline the chief thermodynamic problems in connection with gasoline engines, especially aircraft, the author first discusses the factors that prevent the attaining of the ideal air-cycle efficiency. Following the statement that the power output and the efficiency of any internal-combustion engine depend primarily on the ratio of expansion, since this governs the proportion of the total heat supply which can be converted into useful work on the piston, it is shown that ideal efficiency presupposes two conditions: (*a*) that the working medium is pure dry air and (*b*) that no interchange of heat between the air and the surrounding walls or from the previous cycle takes place. The points brought out in the discussion of the factors that hinder the realization of ideal engine efficiency are indicated below.

The increase of specific heat at high temperatures represents a dead loss as compared with the air-cycle basis, since it means in effect that any heat added at high temperatures is not accompanied by so large an increase in pressure as at the lower temperatures. At the temperatures prevailing in an aircraft engine or indeed in any gasoline engine, namely, between 1800 and 2500 deg. cent. (3272 and 4532 deg. fahr.), the loss due to the change of the specific heat is of a very large order and constitutes the greatest discrepancy between the practically possible and the air-cycle ideal.

Dissociation of the products of combustion at high temperatures does not play such havoc with the power and the efficiency as the change of the specific heat, because it occurs to an appreciable extent only at very high temperatures, so that as the expansion proceeds and the temperatures fall, re-combination with a corresponding liberation of heat takes place and a part, at any rate, of the lost heat is recovered, and that in time for some, though not the full, use to be made of it.

Heat loss to the jackets is yet another factor that prevents the attaining of the ideal air-cycle efficiency. It is not, however, of anything like the magnitude that many people believe. If in an aeronautic engine of good modern design the entire flow of heat to the jackets were suppressed, the net gain in power and efficiency would be about 8 per cent only.

It is clear that the above-mentioned three main sources of loss are directly dependent upon the flame temperature and that if we can reduce this temperature, we shall at once gain in efficiency. Nor is that all, for nearly 90 per cent of present-day engine troubles are due directly or indirectly to excessive heat flow: directly in the form of burnt-out valves, spark-plugs and pistons; indirectly in the form of carbonized oil, gummed-up piston-rings and defective cylinder lubrication.

With reference to the interchange of heat between the residual products of the last cycle and the fresh mixture, the value of absorbing the heat of the products of the previous cycle is stressed.

The influence of the latent heat of vaporization of a fuel is often overlooked, yet it is the one characteristic above all else which determines the power output available from an engine. The fuel with the highest latent-heat will give the highest power output, provided it is volatile enough. The

(*Continued on p.* 16)

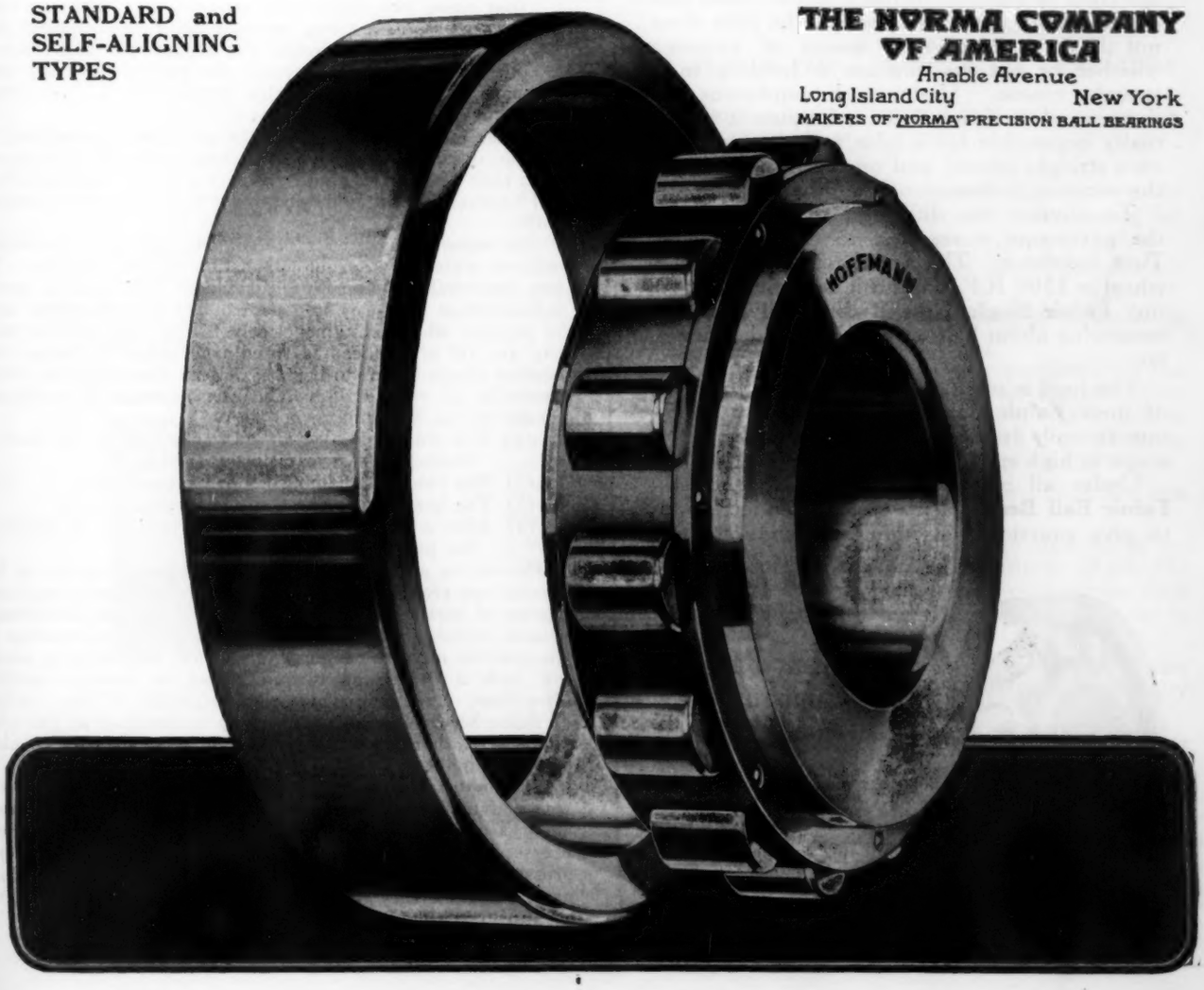
HOFFMANN PRECISION ROLLER BEARINGS

For Heavy Loads and Hard Service

Heavy-duty units manufactured to unequaled standards of precision; affording the maximum of serviceability under conditions involving heavy loads, temporary overloads, shock, jar and vibration; offering to manufacturers and users of automotive machinery new opportunities for power saving, reduced upkeep costs, and better service.

Our engineers will welcome an opportunity to work with yours, in applying these high-duty, high-precision bearings to motor cars and trucks with a view to securing maximum anti-friction efficiency, minimum maintenance costs, and continuity of service.

STANDARD and SELF-ALIGNING TYPES



THE NORMA COMPANY OF AMERICA
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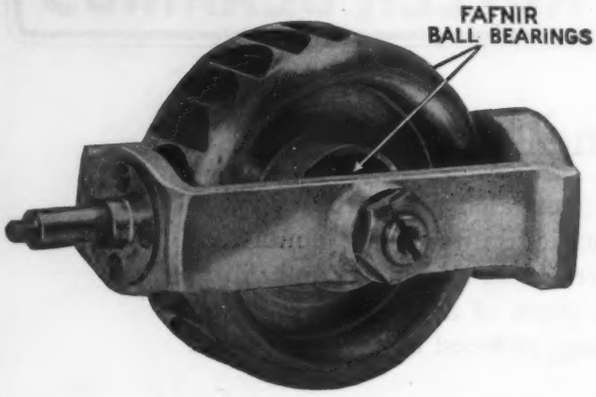
MAKERS OF "NORMA" PRECISION BALL BEARINGS

FAFNIR



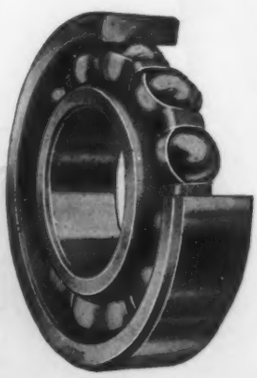
Fafnir Ball Bearings Reduce Friction to the Vanishing Point—As in this Gyroscope

Flying at night or through dense clouds and fog is mighty ticklish business if the pilot does not have some special means of knowing whether or not his airplane is holding to a straight course. Under such conditions the compass alone is insufficient, because it is virtually impossible for a pilot to hold his plane on a straight course, and once a turn is begun, the compass is thrown off meridian.

To obviate this difficulty, the principle of the gyroscope is resorted to in the Pioneer Turn Indicator. The speed of the gyroscope wheel is 5500 R.P.M., and it is carried by two tiny **Fafnir Single Row Radial Ball Bearings** measuring about half an inch in outside diameter.

The load is practically nothing, the function of these **Fafnir Ball Bearings** being to facilitate virtually frictionless operation of the gyroscope at high speed, and this they do.

Under all conditions of load and speed, **Fafnir Ball Bearings** may be depended upon to give practically frictionless operation and long service. There is a **Fafnir** for every bearing purpose.



The Fafnir Bearing Company

New Britain, Conn.

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NEWARK, N. J.
271 Central Ave.
PHILADELPHIA, PA.
1427 Fairmount Ave.

NOTES AND REVIEWS

Continued

author discusses the difference in this respect between the engine working on the explosion cycle and the compression-ignition engine.

Regarding the pre-burning of the mixture during the suction and the compression stroke, it is stated that it is difficult to prove convincingly the presence of this pre-burning, though there can be little doubt as to its existence; it is still more difficult to determine its extent, which is controlled clearly by both the time element and the temperature of the surface. In the ordinary engine cylinder the only surface that is likely to cause pre-burning is the head of the exhaust-valve, and the extent of pre-burning from this surface probably varies as something like the cube of its temperature.

Taking up the question of the actual process of combustion in an engine cylinder, the author says in part:

> As a mental picture the writer prefers to regard the process as though it developed in two entirely distinct stages, one the growth and the development of a self-propagating nucleus of flame and the other the distribution of this flame throughout the combustion-chamber. The former is a chemical process depending upon the nature of the fuel, upon both the temperature and the pressure and also upon what Tizard terms the temperature coefficient of the fuel, that is the relation between the flame temperature and the rate of acceleration. The second stage is a mechanical one, pure and simple. I have suggested that these two stages are separate and distinct, but they must, of course, interact upon one another to some extent, for example the higher the flame temperature and the more rapid the rate of burning, the more rapidly will combustion spread with a given rate of turbulence.

Discussing the first stage in the process of combustion, the author describes at length two long series of experiments that have been carried out by Fenning at the National Physical Laboratory and by Tizard and Pye at the writer's laboratory.

The second stage, it is stated, depends upon turbulence, without which no internal-combustion engine could run. The two essential functions of turbulence are (*a*) to spread inflammation and (*b*) to scour away the stagnant layer of mixture which, clinging closely to the cold cylinder walls, can get rid of its heat so rapidly as either to escape combustion altogether or to burn so late in the expansion stroke as to be of very little value. An increase of turbulence results in the following:

(1) The stagnant layer of gas adhering to the walls is scoured away and brought into use
(2) The rate of inflammation is hastened; but
(3) The heat loss to the walls is increased; and
(4) After a certain point there is a tendency to reduce the possible range of burning

The writer states further that experiments which he has carried out recently indicate that each fuel has an optimum degree of turbulence beyond which any further disturbance results merely in excessive heat-loss and a narrowing of the possible mixture-range, while he has succeeded in reaching such a degree of turbulence as to prevent ignition altogether, presumably by the dissipation of the nucleus of flame before it can become fully established at the plug points; in other words, the draft may be such as to blow out the candle.

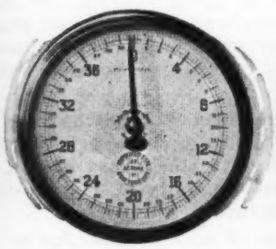
The importance is stressed of determining how far the rate of burning and detonation are dependent upon pressure alone as distinct from temperature, and the author expresses his conviction that under actual working conditions, pressure and pressure alone plays a supremely important part, but it is very difficult to prove this because the temperature control at best is somewhat indeterminate.

(*Continued on p.* 18)

Wasson Motor Check

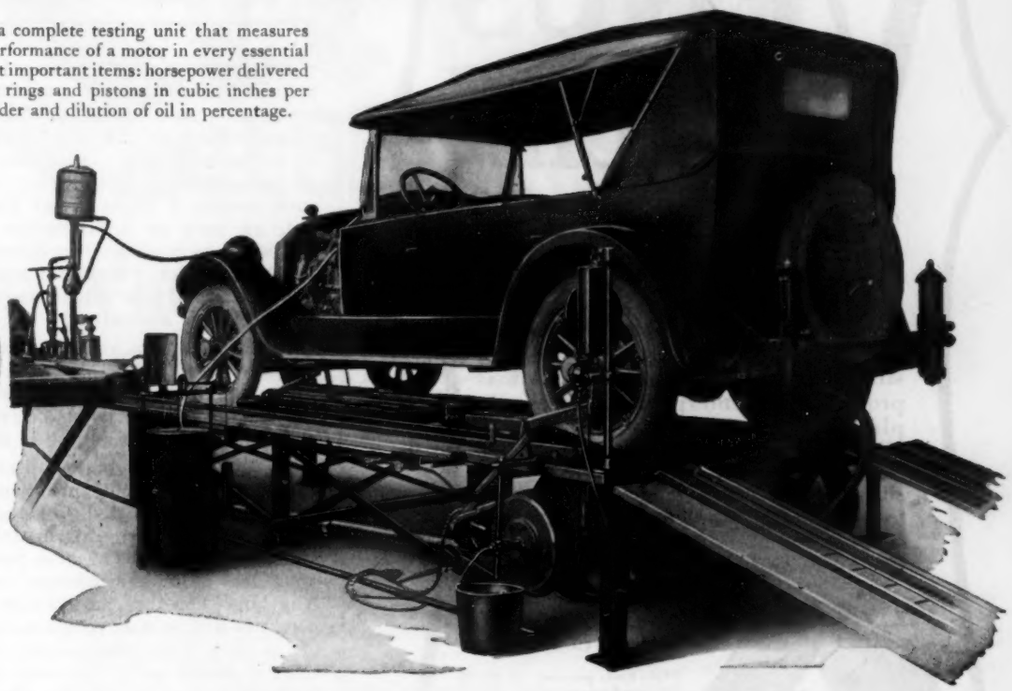
THE Wasson Motor Check is a complete testing unit that measures with scientific accuracy the performance of a motor in every essential factor; including the following most important items: horsepower delivered at the rear wheels, slippage past rings and pistons in cubic inches per minute, compression in each cylinder and dilution of oil in percentage.

If the motor is not right it tells why and where—with mechanical precision.



Horsepower at rear wheels

—one of three dials that gives a positive record of car efficiency at any speed, under any load.



As a Merchandising Factor

The Wasson Motor Check offers important benefits to the consumer and to the trade.

Repair men can diagnose any car by a careful interpretation of the Motor Check findings. That saves all needless expense of cut-and-try methods. After the engine has been brought back to standard—the Motor Check proves the job.

Distributors of motor accessories can prove the relative value of their products by comparative tests on actual cars—under any conditions of load or speed desired. No rule-of-thumb—but specific proof.

Fleet owners can maintain every unit of their fleet, at minimum expense, by a simple system of periodic tests on the Motor Check. No waiting until trouble develops.

In a word—it diagnoses motor troubles;—a generic contribution to the automotive industry.

Wasson Motor Check stations are now in operation at Washington, D. C., Boston, Rochester, Newark, Orange, N. J., Baltimore, Grand Rapids.

A Tell-tale Check on Used Car Values

THE Wasson Motor Check offers the only solution to the problem of fixing the value of used cars.

How?

By providing an *accurate mechanical measurement* of car condition as is. It substitutes facts for guess work; conclusions for arguments; a certified valuation for a fictitious estimate.

Cars turned in for resale in 1923 cost American dealers $2,000,000,000!

This year, a conservative estimate is that 80% of car business will involve exchange and resale.

There's dynamite concealed in the used car problem! All the inherent instinct of the proverbial "hoss trader" is roused to action when your prospect tries to sell you his car. He thinks he knows more about it than you do—but you can't resell it at his price and stay in business!

Can't you see at once how the Wasson Motor Check fits into this picture?

Where confidence and value are at stake there must be an infallible and impartial measuring rod, and the Motor Check fills this need—sets the danger line for you on the car coming in; then on the resale it proves, under the buyer's eyes, that the car is worth your price!

Your banker will tell you that Wasson Motor Check findings are the soundest basis for credit that has ever been devised—the only reliable authority in used car transactions.

Today—prominent motor marts and used car exchanges are developing a program which includes a motor check rating on every car they handle.

Stop gambling with your profits. Here's the solution to the used car dilemma. Write for facts and figures about this vital contribution to better business.

T-N-T Engineering Co., Inc., Newark, N. J.

Manufacturers of T-N-T Piston Rings and the

Wasson Motor Check

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NOTES AND REVIEWS

Continued

Reference is made to stratifying the charge, separating it into two component parts, one consisting of a comparatively rich and rapid-burning gasoline-air mixture, in the neighborhood of the spark-plug, and the other of pure air to act as a diluent; these two components being kept more or less separate until after the ignition of the first. By such means a high initial flame temperature is obtained; but, as soon as inflammation is fairly started, the flame temperature is reduced by dilution with the excess air present in the cylinder. Experimental work in this connection is described, and the advantages of stratification are stated, especially for aircraft.

The advantages and the drawbacks of supercharging are discussed, and it is stated that if one works with a stratified charge, one can then supercharge to almost any extent. In this connection the comparative suitability of a sleeve-valve and a poppet-valve engine is shown.

To sum up, the biggest item of loss is that due to the change of the specific heat; next comes the direct heat-loss to the cylinder walls, followed by detonation which limits the expansion that can usefully be employed, dissociation and pre-burning. The first two are both directly dependent upon the flame temperature and the next two largely so. Anything therefore that can be done to reduce the flame temperature will be a direct gain, but with all fuels except hydrogen a very high temperature is needed to promote combustion; it would seem therefore that it is necessary to concentrate on trying to stratify the charge and by so doing try, in effect, to mislead the mixture by allowing a high flame-temperature at the start but diluting it immediately afterward.

Pre-burning is no doubt a serious trouble, for not only is some of the charge lost but, when the temperature is raised prematurely, detonation is provoked, and so a lower compression must be used than would otherwise be necessary. Hot exhaust-valves are the main, almost the sole, cause of pre-burning, which can be eliminated almost entirely by the use of sleeve valves, as they involve no highly heated surfaces in the combustion-chamber.

In conclusion, the author says:

> If the writer had at this moment to design engines for aircraft, he would, for the light, fast-scouting machines, go for an air-cooled radial engine with poppet valves, a very high compression, using dissolved water or a fuel of very high latent heat for getting off the ground, with possibly a little, but certainly only a very little, direct supercharging at high altitudes. For the heavier classes of machine he would, in the light of present knowledge, go for a water-cooled sleeve-valve engine with stratified supercharge.

THE VECTOR-RULING PROTRACTOR. By A. F. Zahm. Published in *Journal of The Franklin Institute*, February, 1924, p. 209.

The author presents the theory, the structure and the working of an instrument, devised by him, for use in wind-tunnel work, to find the line of a vector. Given, for example, the lift, the drag and the pitching moment on an airfoil or a complete airplane model, only the line of the resultant air force is to be drawn. This can be done, with the magnitude of the force unknown, by the use of a circular protractor and guiding straight-edge along which it can move, and it is an instrument of this kind that is described in this paper and illustrated by diagrams.

Emphasis is placed on the amount of time saved by employing a ready means of sketching the air forces on a model during a wind-tunnel test.

(*Continued on p.* 20)

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A STROM trade-mark on a ball bearing means that

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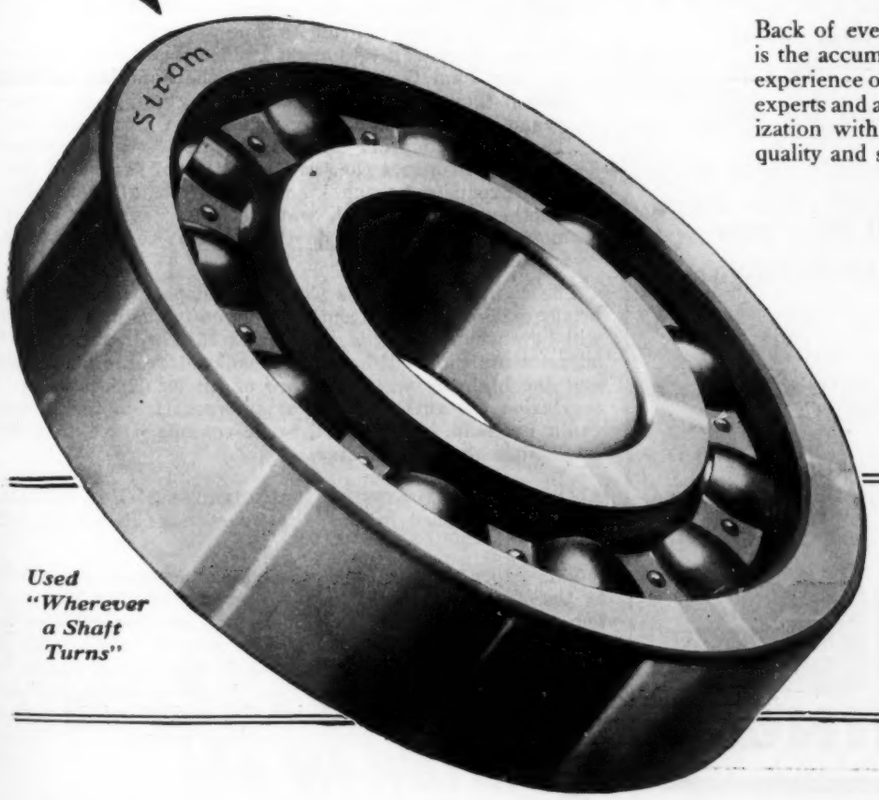

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NOTES AND REVIEWS
Continued

TWO GAGES FOR AERONAUTIC-ENGINE CYLINDERS. By W. H. Thompson. Published in *American Machinist*, Feb. 21, 1924, p. 297. 3 illustrations.

Two gages are illustrated that are designed for checking the cylinders of an air-cooled aeronautic engine. A diagram shows how a single gage checks the following dimensions: the maximum diameter of the cylinder spigot, the end of the spigot, the maximum overall dimensions of the cylinder flange, the positions of the cylinder bolt-holes, the length of the spigot below the flange, the length from the cylinder flange to the inside of the head and the length from the cylinder flange to the outside of the head.

VEHICLES WITH MORE THAN TWO AXLES. By George W. Watson. Published in *The Automotive Manufacturer*, February, 1924, p. 21.

In this paper, which was read before the Road Traffic Conference in London, November, 1923, the author states as the chief reason for the development of the multi-wheel vehicle the fact that by its use loads may be doubled or trebled without increasing the labor charge and without seriously increasing the rate of fuel consumption, the wear of tires or the cost of repairs and depreciation. The paper contains a discussion of the various points that must be considered in designing a six-wheel vehicle, chief among them being the questions of steering, of body distortion and of suitable brakes.

RAILROAD HIRES TRUCKS TO HAUL ITS FREIGHT. By F. C. L. Robinson. Published in *American Motorist*, February, 1924, p. 3.

The action of the Pennsylvania Railroad, in substituting motor trucks for two daily package freight trains transporting less-than-carload shipments, receives comment. The article says, in part:

> This step is looked upon as the beginning of the economic readjustment of transportation, the ultimate objective of which is the operation of the motor truck over the highway within its zone of usefulness and the release of the rail equipment and the men formerly used in short-haul transportation for the handling of bulk and distance shipments. It is the beginning of a practical coordination of different kinds of transportation. The final adoption of an adequate transportation scheme will insure the transportation of farm and factory products by the kind of transportation service, whether it be by rail, water, electric systems or by motor truck, that can do the work at the lowest cost for the service required.

The significance of this shift in transportation methods is briefly explained, and attention is given to the difficulties that will be encountered, the complaints that will arise and the adjustments that will have to be made before the motor truck and the highway will take care of all local shipments. In conclusion the author quotes a statement from the Pennsylvania Railroad, setting forth some reasons why the railroad established the truck system.

ADEQUATE RECORD SYSTEM CHARACTERIZES 21-BUS INSTALLATION. Published in *Bus Transportation*, February, 1924, p. 51.

This paper shows how costs and performance are checked by the officials of a public service corporation and how a system of records is used as a means of keeping vehicles and maintenance up to the mark. The records that enable the executives to watch operations and to modify methods or improve processes are described, and 13 forms are reproduced, including the weekly labor ticket, the analysis of the maintenance payroll and the general overhaul report.

(*Continued on p. 22*)

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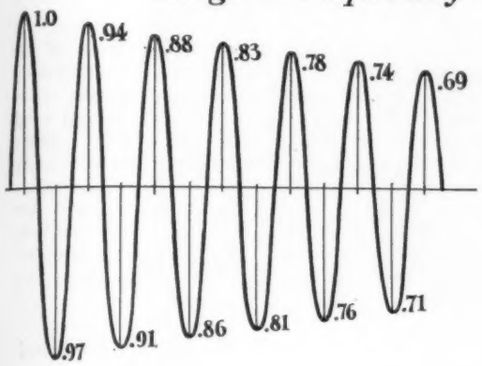

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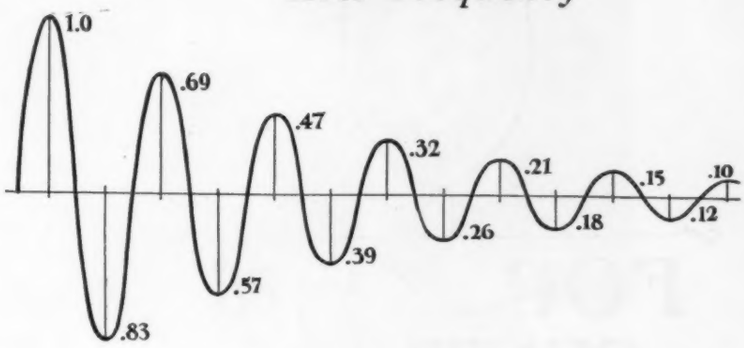

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NOTES AND REVIEWS

Continued

ONE CLERK INSTEAD OF EIGHT WITH RECORDING DEVICE. By H. Lionel Williams. Published in *Motor Transport*, Feb. 15, 1924, p. 56.

A system is described that expedites the handling of all the motor-transport records of a county road department. Daily records, kept on cards, include such items as the mileage, the hours run, the gasoline used and its cost, the oil used and its cost, repairs made and accessories bought. Each month the items on the cards are totalled, and the resultant figures are entered on an automobile-maintenance report that gives the total cost of maintenance for the month and the cost per hour run, for each machine. A thorough check is maintained on the use of the vehicles, and the exact proportion of the operating charges can be allocated to the right departments and jobs.

IS THE BALLOON TIRE READY? By H. O. Smith. Published in *Tires*, February, 1924, p. 27.

The author reviews some important factors that must be considered by producers and dealers before the low-pressure casing can be definitely accepted by the industry. The tendency of balloon tires to shimmy is mentioned and the cause of this action is discussed. The statement is made that, although balloon tires lessen the skidding tendency, they do not make the use of chains unnecessary under certain conditions that motorists commonly encounter and that any equipment which precludes the possible use of chains should not be considered.

HOW AUTOMOBILE-TIRE MOLDS ARE MADE. By Charles O. Herb. Published in *Machinery*, March, 1924, p. 497.

A brief outline is given of the manner in which molds and forms are used in tire manufacture, and the methods employed in machining and engraving these molds are described in detail. The tread design is engraved in the mold halves, after the molds and the forms have been machined on boring and turning mills. The engraving machines generally operate on the pantograph principle, the design of the tread being traced from a model of some sort that is made on a scale several times the size of the tread design itself so as to reduce any errors to a negligible quantity. The model usually has only one complete division of the design, the tread being produced around the entire mold by indexing the table of the engraving machine.

PREVENT TRACTION LOSS WHEN REAR WHEEL SLIPS. Published in *Motor Vehicle Monthly*, March, 1924, p. 47.

Two devices that embody the principle of permitting unequal rotation of the driving wheels of an automobile when required, without causing loss of traction when one wheel runs on slippery ground, are briefly described.

One of the two devices is a differential that contains no gears, pawls and ratchets. All of its parts are made of drop-forged steel. On a spider plate are mounted cams that slide in circular openings cut in the spider. Four driving lugs are located on the spider slightly below the surfaces of the cams. These lugs engage with others on clutch pieces that are keyed by hubs to the ends of the axle shafts. A large coil-spring inside the differential housing keeps the lugs in their engaged position. Driving power is applied on the spider. If one wheel should overrun the driving member, the cams will cause the lugs on the clutch pieces to slip out of engagement with those on the spider. As the cams are slightly higher than the spider lugs, the clutch lugs will then ride on the cams and not on the surfaces of the spider lugs. The spring will force the clutches in place again.

The other device is a driving axle incorporating an automatic differential lock comprising a jaw clutch with V-shaped

(*Continued on p.* 24)

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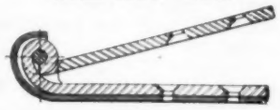

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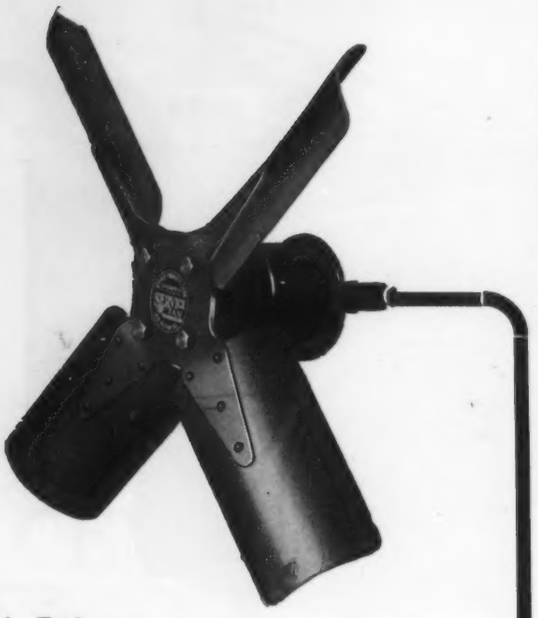

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SERVICE FLOOD OILING FAN

NOTES AND REVIEWS

Continued

teeth and a coil spring that normally holds the teeth in engagement. The angle of the clutch teeth and the force of the spring by which the clutch teeth are held in engagement are so proportioned that the clutch will not open until the torque on the clutch parts becomes equal to one-half that required to slip one wheel on dry ground. Thus, when the car is being run in a straight line, the rear axle is virtually solid and the car will not lose its traction when one of the driving wheels gets on a slippery stretch. In turning a corner the torque will at once reach the extent requisite to open the clutch and, when the clutch opens, the wheels are independent of one another.

HIGHWAY RESEARCH IN ILLINOIS. By Clifford Older. Published in *Proceedings of the American Society of Civil Engineers*, February, 1924, p. 175. Illustrated.

In this paper are described a series of research projects carefully planned to give an understanding of the unsolved problems of rural pavement design.

The principal problems investigated include the drainage of sub-grade soils, the effect of repeated bearing-pressures on soils, the effect of temperature changes on pavement surfaces, the position of wheel loads as affecting stresses in the pavement slabs, impact resulting from moving wheel-loads and the fatigue effect of repeated loads causing bending stresses in plain concrete.

A test road was constructed so as to eliminate so far as possible the variable factor of sub-grade bearing power. Six groups of test sections were built, each representing a given type of pavement. Each group included a series of sections graduated in thickness and strength from light to heavy and presumed to be comparable with corresponding sections of the other groups. The test road was subjected to a graduated artificial truck traffic, beginning with wheel loads of 2500 lb. and ending with wheel loads of 13,000 lb.

In this paper are described briefly the methods used in the investigations, the data obtained and the tentative conclusions drawn from these studies.

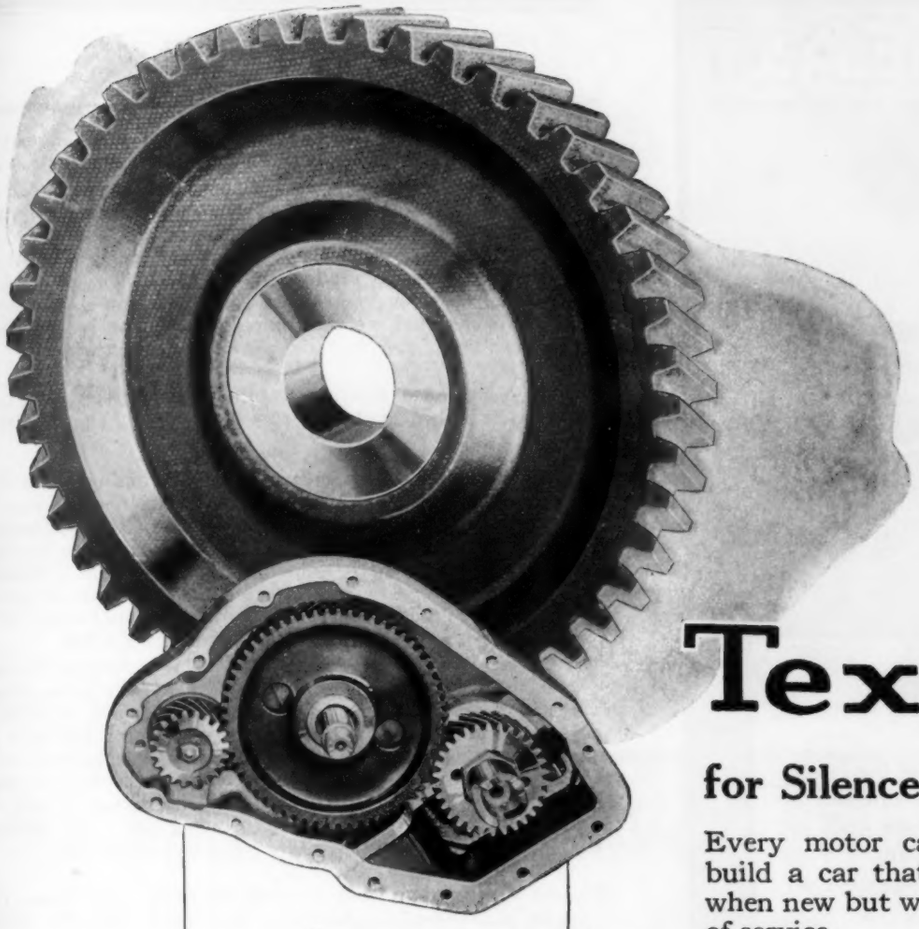
THE MOTOR-FUEL PROBLEM. By Fred H. Rhodes. Published in *The Sibley Journal of Engineering*, February, 1924, p. 42.

After calling attention to the fact that within a very few years we shall be faced with a serious shortage of petroleum and shall have to develop new sources of motor fuel to supplement or replace gasoline, the author mentions the two general methods of attack for this problem. They are (*a*) to improve the design of our internal-combustion engines so that the gasoline which we have will be utilized more efficiently and will last for a longer time and (*b*) to increase our supply of motor fuel by increasing the yield of gasoline from crude oil or by developing new sources of motor fuel.

In the discussion of engine design, the advantage of increasing the compression-ratio of engines operating on ordinary gasoline is stressed, but on the other hand the reasons that make this increase impracticable are stated. In this connection, mention of anti-knock compounds is made.

Methods of increasing the fuel supply are next considered. The yield of gasoline from crude petroleum can be increased by including more of the kerosene material and by cracking processes. The extent to which each of these operations is practicable is shown, as well as the extent to which each is impracticable. Other substances are mentioned to supplement or replace gasoline as a motor fuel, such as alcohol, benzol, coke-oven light-oil, fuel obtained from products of the carbonization of coal at low temperatures and shale oil. The factors of cost, the amounts producible and the advantages and the disadvantages as a motor fuel are discussed

(*Continued on p.* 26)



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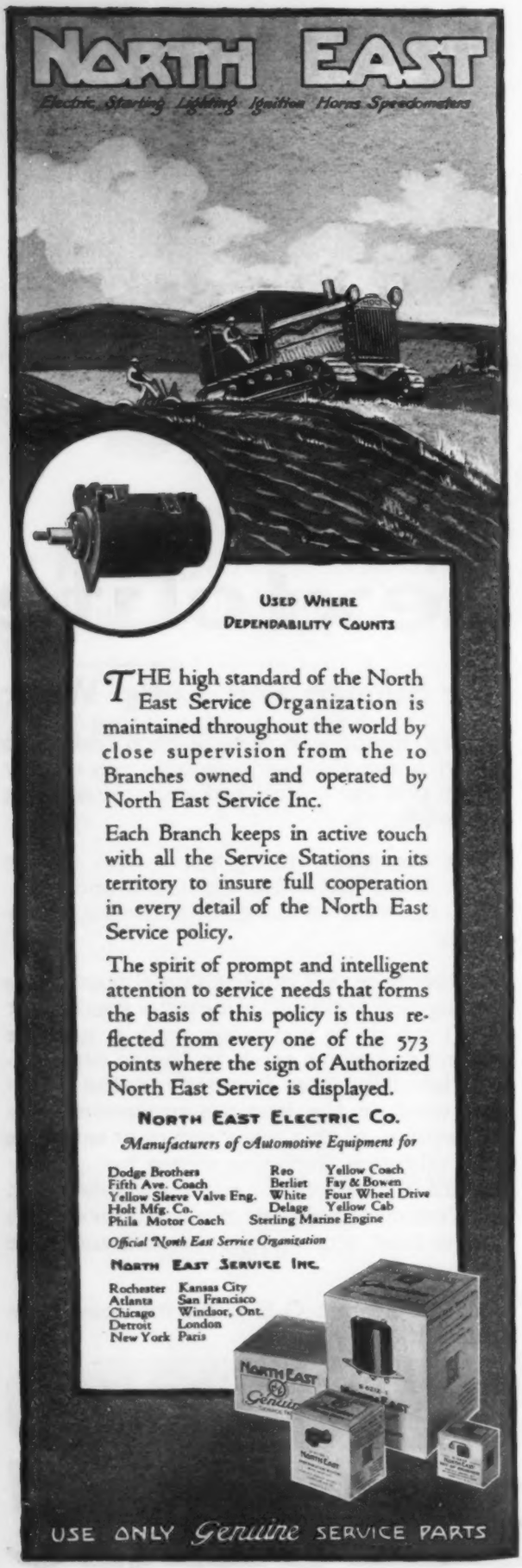
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NOTES AND REVIEWS

Continued

in each case. It is shown in particular that shale-oil motor-fuel will be much more expensive than is gasoline at present.

It is stated that the total amount of motor fuel that can be produced in this Country annually at a cost of 30 cents per gal., exclusive of that derived from petroleum and from oil shale, would be, according to estimate, but slightly more than one-half of our present production. In conclusion, the author states that, when our petroleum supplies become exhausted or seriously depleted, we shall have to do one or both of two things: use less motor fuel and pay a higher price for it.

SPECIAL TOOLS AID SERVICE STATIONS TO PROFIT ON FLAT RATE. Published in *Automotive Industries*, Feb. 28, 1924, p. 518.

An investigation of discrepancies in the time required for similar repairs shows two reasons: (*a*) variations in equipment and (*b*) differences in the knowledge of the equipment and the ability displayed in its use. It is shown that for the flat-rate system to apply properly throughout the Country, tool equipment must be standardized and must be designed so that the skill of the individual mechanic is no longer such an important factor in the time required for the job.

The system used by one company in this connection is described. The tools recommended are divided into three classes, corresponding to the size of the business in which they are to be used. The dealers are being provided with a chart on which an illustration of the tool-cabinet and of each tool in actual use is presented. In addition, a booklet has been prepared which pictures each tool, tells how to use it and dwells on the importance of utilizing the tools recommended if the flat-rate schedule is to be met profitably.

HOLLOW CONNECTING-RODS IN THE MAKING. By Fred H. Colvin. Published in *American Machinist*, Feb. 28, 1924, p. 311, and March 6, 1924, p. 351.

These articles deal with the operations on the connecting-rods for Wright airplane engines and describe the special fixtures and the methods employed for securing light weight, accuracy and ample strength. Illustrations and accompanying explanations show in detail the rod, the tools used and the methods involved. For example, one diagram in the first article, showing the details of the outer connecting-rod, gives not only the main dimensions and the tolerances but also an idea of the kind of workmanship demanded. In the second article, the inner rod is illustrated and discussed.

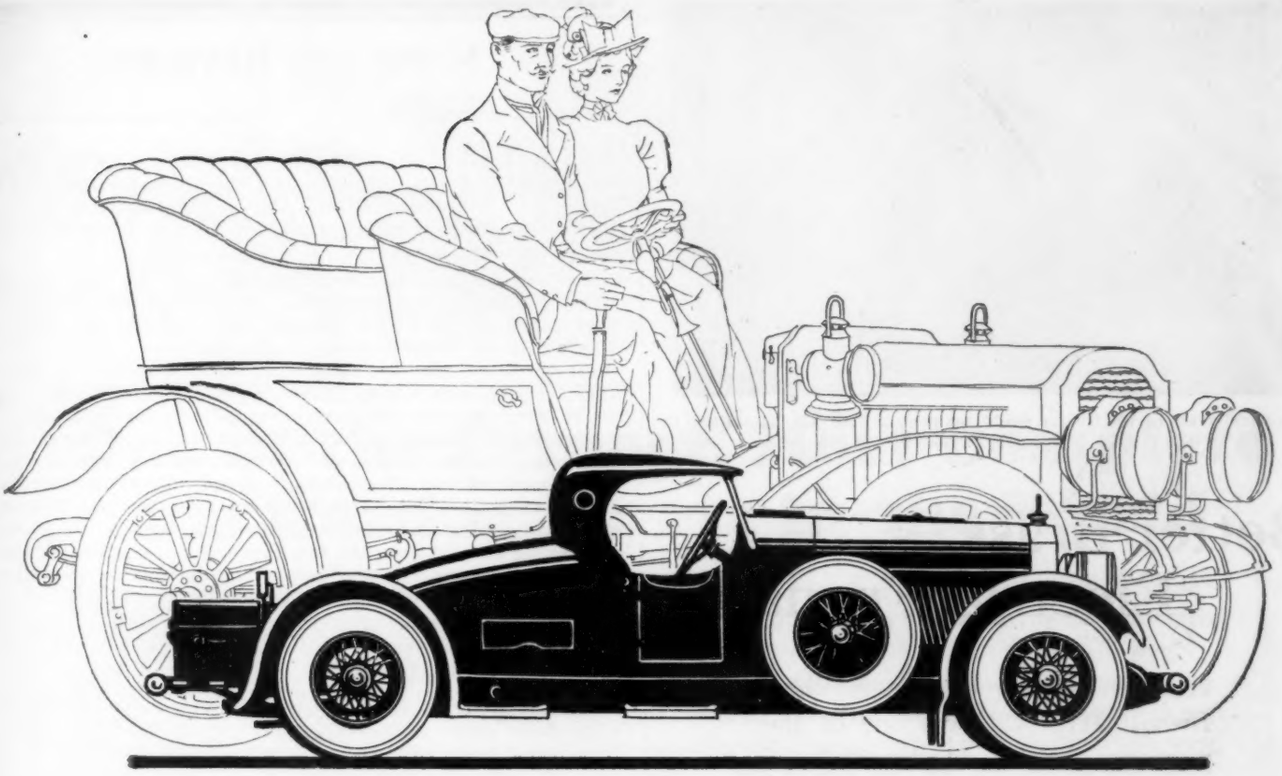
FORGING AND SMITHING. By Lynn C. Jones. Published by The Century Co., New York City. 211 pp.; illustrated.

This book, covering the subject of metal working in all its phases, especially work in iron and steel, is designed primarily for use in the teaching of blacksmithing as a trade or occupation in day, evening or part-time classes and in the teaching of forging in schools where an elementary knowledge of it is a necessary or a valuable part of the requirement for such work as farming, metal working, machine-shop practice, tool making, automobile work, electrical work and sheet-metal work. The Appendix of 25 pages, giving numerous tables of weights, sizes, shapes, speeds, working temperatures and the like for all the ordinary materials used by a blacksmith, is meant to furnish a complete handbook of information for the student in the classroom and the workman in the shop.

MODERN AUTOMOBILE FOUNDRY PRACTICE. By P. Pritchard. Published in preprint form by The Institution of Automobile Engineers, London. 44 pp.; illustrated.

After briefly dealing with the broad principles of foundry practice, the author passes on to a consideration of the metals

(*Continued on p.* 28)



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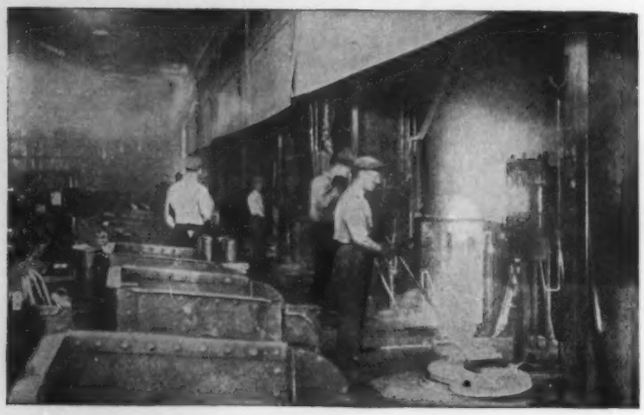

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NOTES AND REVIEWS

Continued

used for castings in automobile construction, chiefly aluminum and its alloys, cast iron, malleable cast iron and mild steel. The processes of melting, molding, overcoming defects, die-casting, core-making, cylinder-casting and centrifugal-casting are discussed.

Taking into account the impossibility of dealing exhaustively with every aspect of foundry practice, the author of this paper claims to have considered only the outstanding points relating to the production of automobile castings. The need for more scientific control is stressed and it is stated that there is room for an immense amount of research work to be done, as very little reliable information is available concerning the behavior during cooling of any of the metals mentioned in the paper. Closer cooperation between the maker and the user of castings is urged, and the author enlarges upon the scope and the possibilities of the hitherto practically-unknown position of foundry engineer to be the connecting link between the foundry and the engineer, assisting design on one side and helping production on the other.

THE STORY OF FERROCHROMIUM. By Frederick M. Becket. Published in *Chemical and Metallurgical Engineering*, Feb. 25, 1924, p. 316.

Chrome steels, it is stated, were among the very earliest alloy-steels developed. This paper briefly discusses alloys that range from as little as 1 per cent of chromium to a product containing more than 98 per cent of chromium. Chrome steels are valuable because of the properties of hardness, toughness and resistance to abrasion that they possess after heat-treatment. Chromium increases the strength and the hardness of an engineering steel without destroying the toughness and the ductility; it is more effective than any other alloying element in retarding the corrosion reactions, because it divides itself between the carbides and the solid solution with greater concentration in the latter, which fact gives one explanation of the non-rusting quality of stainless steel.

Stainless steel and rustless iron alike contain between 12 and 14 per cent of chromium, but they differ considerably in the carbon-content. This difference in the amount of carbon contained appreciably influences the properties. Stainless steel requires a hardening treatment to induce the condition of maximum non-corrodibility; rustless iron does not require such heat-treatment and is furthermore much softer than stainless steel and more readily rolled, forged and cold-worked.

EMBRITTLEMENT OF MALLEABLE CAST-IRON RESULTING FROM HEAT-TREATMENT. By Leslie H. Marshall. Bureau of Standards Technologic Paper No. 245. Published by Government Printing Office, City of Washington. 17 pp.

The results of an investigation are detailed in this paper, showing that commercial malleable cast-iron is embrittled to a greater or less degree, depending on the iron, by quenching from certain temperatures in the "blue-heat" range, such as are obtained in the hot-dip galvanizing process. This drop in the impact resistance is lessened by slow cooling but is not affected by subsequent aging. The fundamental cause of this behavior is not yet known. The embrittlement can be eliminated, however, by heating to 650 deg. cent. (1202 deg. fahr.) for a few minutes.

WET-PROCESS ENAMELS FOR CAST IRON. By R. R. Danielson and H. P. Reinecker. Bureau of Standards Technologic Paper No. 246. Published by Government Printing Office, City of Washington. 41 pp.

This paper deals with an investigation of vitreous enamels to be applied to cast iron by the wet process, both with and

(*Continued on p.* 30)

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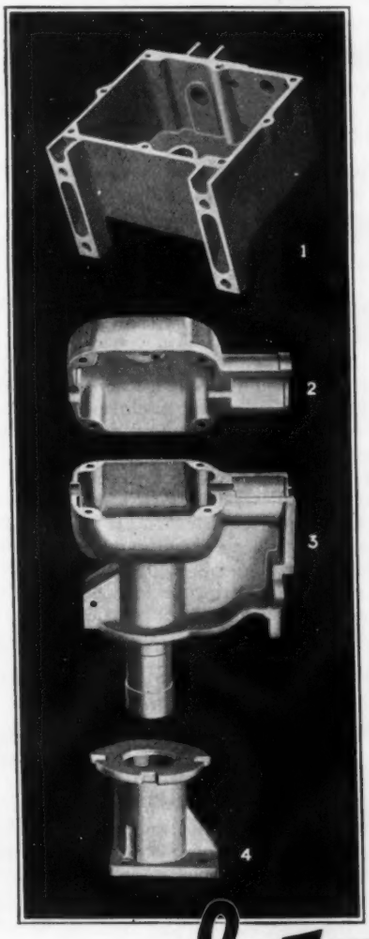

THOSE who have visited this great factory have been astounded at our tremendous facilities, at the millions of die castings which we turn out and at the thoroughness of our metallurgical work.

Great machines of our own invention shoot out castings accurate to the thousandth of an inch at an unbelievable rate; dies made in our own departments represent developments in the industry which were thought impossible a few months ago; our engineering and metallurgical departments are perfecting alloys to the uses of the castings to add strength, lightness, hardness and ductility as desired.

Above all, we have organization and equipment which is making it possible for us to give SERVICE in deliveries. Scores of manufacturers have entrusted this all-important production work to us. As a result, we have one of the largest, most complete die casting plants in the world.

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2 **This Casting and the Two Below Weigh** 17 Pounds. By die casting this part, the manufacturer saved [1] boring and facing, [2] side facing, [3] drilling four holes, and [4] milling four slots.

3 Die casting this part alone saved eleven operations such as [1] turning stem, machining flange, drilling ¾-inch hole, counterboring one inch deep, [2] roughing and finishing top face, [3] milling locking slot, [4] facing bosses inside, [5] milling pad for bracing beam, [6] drilling eight holes, [7] tapping seven holes, [8] inserting bushing, [9] assembling with cap, [10] grinding parts 2 and 3 flush, [11] disassembling.

4 Six machine operations were saved by die casting this part. Such examples of actual production economies only suggest the possibilities in many other businesses. Send us your blue prints.

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A Kelly - Springfield truck tire for every requirement

For heavy duty trucks, the famous Kelly Kat—the original notched tread truck tire—a massive tire that cushions the truck, gives wonderful traction and consistently delivers big mileage.

For light or medium weight trucks or for the front wheels of heavy trucks, the Kelly Aircore, a scientifically designed hollow-center, double-cushion tire which gives practically the resiliency of a pneumatic.

For trucks requiring tires of maximum resiliency, the Kelly Commercial Cord, a truck pneumatic of special design and extra strength and ruggedness, is breaking all records for service.

For any service where plain solid tires are desirable, the new Kelly High Standard will be found a vast improvement over the ordinary solid on account of its high profile, which insures greater resiliency and longer mileage.

We shall be glad to help you to decide which tire is the best for your particular needs. Address the Engineering Service Department.

Kelly-Springfield Tire Co.

250 West 57th St., New York

NOTES AND REVIEWS

Continued

without ground coats. The study includes the effect of variations in the compositions of ground coats, white cover enamels and both colored and white single-coat enamels. Suitable technique for the preparation and the application of the enamels is discussed.

CARBON AND CARBON-VANADIUM STEEL CASTINGS, A COMPARISON. By J. M. Lessells. Published in *Transactions of American Society for Steel Treating*, February, 1924, p. 144.

This paper has been compiled to give comparative results for carbon and carbon-vanadium steel castings in the annealed and normalized conditions when tested statically and dynamically, the test-pieces being cast in coupon form.

On the basis of these coupon tests, evidence is given to show that the addition of vanadium as an alloying element greatly improves the quality of the material, more especially when tested under dynamic conditions.

The results discussed in this paper have been obtained in the research department of the company with which the author is associated.

DATA ON ALUMINUM ALLOYS FOR AIRPLANE STRUCTURAL WORK. By Fred H. Colvin. Published in *American Machinist*, Feb. 14, 1924, p. 235.

Diagrams, accompanied by explanations, show the work that has been done along the line of standardizing channels, struts and other parts for the construction of all-metal airplanes. Similar data are given on the sizes and the strength of rivets and the distribution of weight.

LIGNUM-VITÆ OBSOLETE FOR STERN BEARINGS. Published in *Motorship*, February, 1924, p. 110.

A rubber bearing is described which may be used instead of hard wood and white metal for stern-tubes on small and large motor craft. The chief advantages claimed for the rubber bearing are its wearing qualities and its practicability for bearing conditions where water may be used as a lubricant. The action of sand or grit with reference to a metal bearing is contrasted with its action with a rubber bearing. It is claimed that the permanent deformation of a rubber bearing is impossible, owing to the resiliency of the bearing surface and that, when operating on a misaligned shaft, the rubber bearing acts as a shock-absorber and prevents undue vibration being transmitted throughout the length of the shaft.

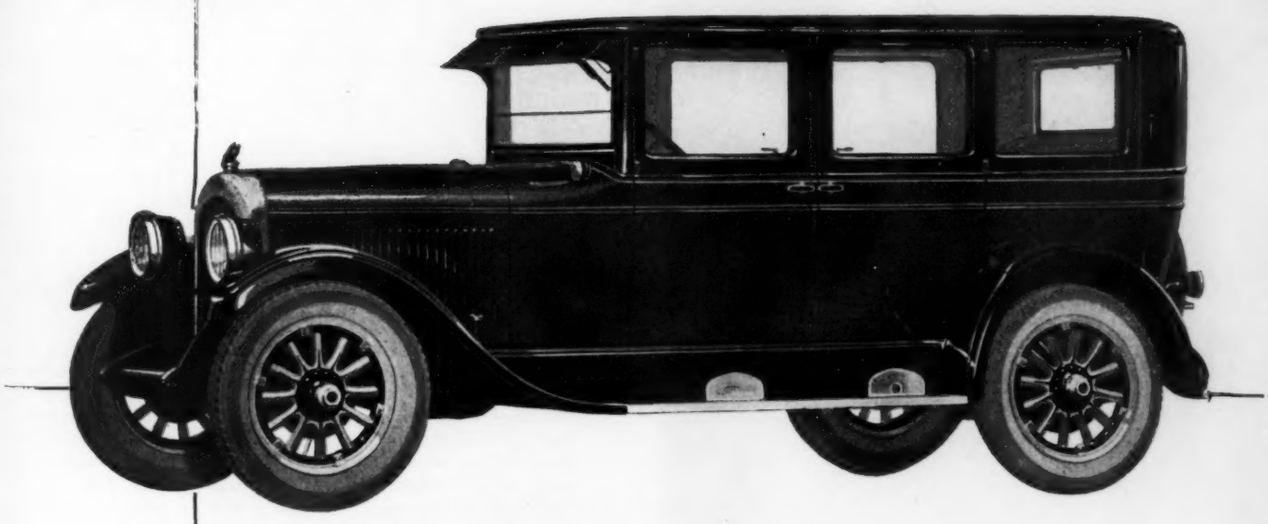
A 2000-TON GEARED DIESEL SHIP. Published in *The Motor Ship*, February, 1924, p. 382. 6 illustrations.

A new system of motorship machinery is described, the first installation of which is now being fitted on a 2000-ton ship that was launched in January. The arrangement calls for the employment of two high-speed Diesel engines, driving a single propeller-shaft through ahead and astern hydraulic couplings and mechanical reducing gear, so that the propeller turns at a suitably low and efficient speed.

It is stated that, in developing their new gear, the designers proposed to decrease the weight and the cost of motorship machinery by the employment of high-speed engines and to utilize slow-running propellers without involving the disadvantages of the direct-coupled mechanical gear, which render necessary large flywheels and flexible shafts between the engine and gear to protect it from the effects of torsional vibration.

A very high efficiency is claimed for the gear. One of the important claims for the hydraulic coupling is that it practically eliminates any torsional vibration generated by the Diesel engines.

(*Concluded on p.* 32)



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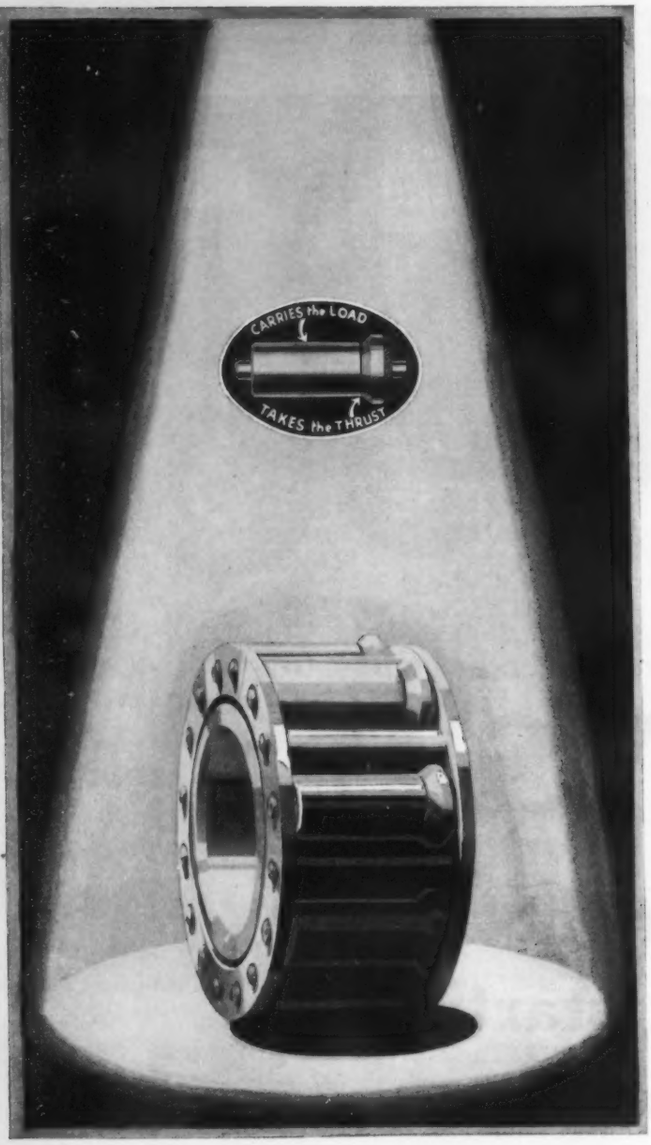

When an engineer specifies Bower Roller Bearings for a car or truck, he knows that this is one part he can conscientiously forget. They seem to serve everlastingly with no adjustment or additional service. And to manufacturers, as well as car owners, this is of inestimable value.

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Detroit Michigan

NOTES AND REVIEWS

Concluded

WORM GEAR, ITS PRODUCTION AND EFFICIENCY AND ITS APPLICATION TO TURBINE REDUCTION-GEARING. By F. W. Lanchester. Published in *Engineering*, Feb. 1, 1924, p. 131.

It is shown that an important feature in which the worm gear differs from a spur gear is that the transmission axes are at an angle, commonly at right angles, one to the other, and that entirely apart from the relative merits of the worm gear and the spur gear as a means of gearing this is a fact that cannot be ignored in its relation to marine propulsion. In discussing this point the author says:

> The use of a right-angle transmission involves the arrangement of the turbine with its axis either athwartships or vertical, in any case at right angles to the direction of motion of the ship, with the consequence that gyroscopic moments are set up, due to rolling instead of, as when the turbine shafts are parallel to the propeller shaft, being only brought into play when pitching. It is true that the angle of transmission of a worm gear need not be 90 deg., but the same objection applies in greater or less degree whatever the transmission angle may be.

Two types of worm gear in general use for power transmission are mentioned and their respective merits and disabilities are discussed. The two types are as follows: (*a*) the type in which the driving element, the worm, is parallel and is, in fact, a quick pitch screw such as can be produced on a lathe and rectified by grinding, and (*b*) the type, sometimes known as the Hindley type, in which the worm embraces the wheel just as the wheel embraces the worm. The former depends definitely upon the employment of gear-tooth form, but the latter is independent of tooth form as ordinarily understood. A summary at the end of this article says in part:

> Stated briefly, the author of the present article is not impressed with the prospects of the general use of the worm gear as a turbine reduction-gearing. The factors that control the situation are to a great extent those of cost and commercial expediency and convenience, in all of which the worm gear appears at a disadvantage. Beyond this there is, it is believed, a slight advantage in efficiency in favor of a well-cut and well-mounted helical gear as against a worm gear, possibly as much as 1½ per cent under good working conditions. This may not look much as a percentage of the total, but where thousands of horsepower are concerned it is substantial. Looked at as a percentage of the heat to be carried away rather than a percentage of the total transmitted, it is clearly a quantity that cannot be neglected.

An appendix to the article consists of a hitherto unpublished report of the National Physical Laboratory on worm gearing.

INTERFERENCE BETWEEN HELICAL GEARS ON PARALLEL SHAFTS. By John B. Arnold. Published in *Machinery*, March, 1924, p. 538. 3 illustrations.

The author gives an analysis of the calculations that he employed in deducing formulas that enabled him to redesign a helical ring-gear and pinion to meet the requirements of a fixed ratio and center distance.

CHINA WOOD OIL IS USED AS BASE FOR BAKED COLOR ENAMEL. By W. L. Carver. Published in *Automotive Industries*, Feb. 14, 1924, p. 324.

A new process is described which has been developed to produce several shades, the claim being made that the same equipment is used as in the old process and that only a slight variation is necessary from the regular routine of the black-enameling department.

KERITE
A product of over fifty years distinguished service in the most important electrical fields, possessing inherent characteristics which make it pre-eminently desirable for
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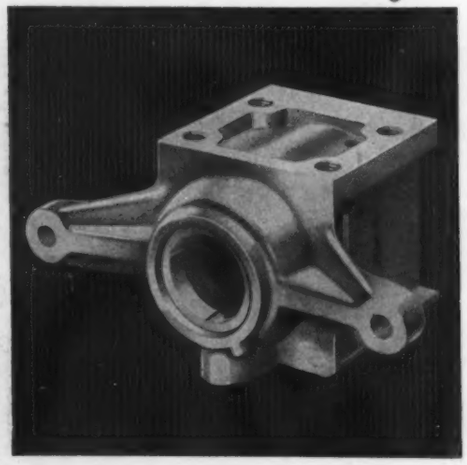

A successful compromise between price and quality has never yet been arranged. Responsible manufacturers never attempt it—responsible purchasers never really expect it.

There is no recorded instance of gold dollars having been purchased for less than 100 cents—and there never will be.

Each Doehler Die-Casting has a quality that is honestly measured by its price. Each dollar paid for a Doehler Die-Casting buys 100 cents' worth of sound serviceability, accuracy, strength, metal quality, satisfactory service.

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Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

A. S. Adams has joined the experimental department of the Chevrolet Motor Co., Detroit. He formerly attended the University of Michigan, Ann Arbor, Mich.

R. C. Barron has severed his connection with the Chandler Motor Car Co., Cleveland, where he was research engineer. His plans for the future have not been announced.

Samuel Berkowitz has gone into business for himself in Hazelton, Pa. He was formerly president and general manager of the Automotive Products Corporation, also in Hazelton.

P. E. Biggar has accepted a position as designer with the Eastern Engineering Co., Montreal, Canada.

Purling A. Bleakley is no longer president of the Utility Products Co., Los Angeles, Cal., but has been appointed factory representative for Southern California for the C. Kenyon Co., Brooklyn, N. Y.

W. J. Bothwell has resigned as district sales manager of the Union Drawn Steel Co., Detroit, and together with others has incorporated the Higgins-Bothwell Co., also of Detroit.

Edward E. Britigan has been appointed engineer in the tool engineering department of the Detroit Gear & Machine Co., Detroit.

Alfred Christensen is no longer mechanical engineer at the Rock Island Arsenal, Rock Island, Ill., but is mechanical draftsman for the Western Electric Co., Inc., Chicago.

O. W. L. Coffin, who was formerly manager for the Manford Cadillac Co., Houston, Tex., is now sales manager for the Ideal Truck Equipment Co., Chicago.

Stuart D. Cowan, together with others, has formed a partnership to be known as Cowan, Dempsey & Dengler, Inc., New York City. Until recently he was Cleveland manager for the J. Walter Thompson Co.

William J. Cumming has accepted a position as designing engineer for the American Motor Body Corporation, Philadelphia. He previously was designing engineer on multiple-wheel trucks and buses for the Goodyear Tire & Rubber Co., Akron, Ohio.

Herbert Dalton has severed his connection with the General Motors Truck Co., Pontiac, Mich., where he was tool and die designer in the engineering department. No announcement has been made of his future plans.

J. E. Davies, who until recently was associated with the Alberta Foundry & Machine Co., Medicine Hat, Alberta, Canada, is now president of the Canadian Farm Implement Co., also of Medicine Hat, with which the Alberta Foundry & Machine Co. has amalgamated.

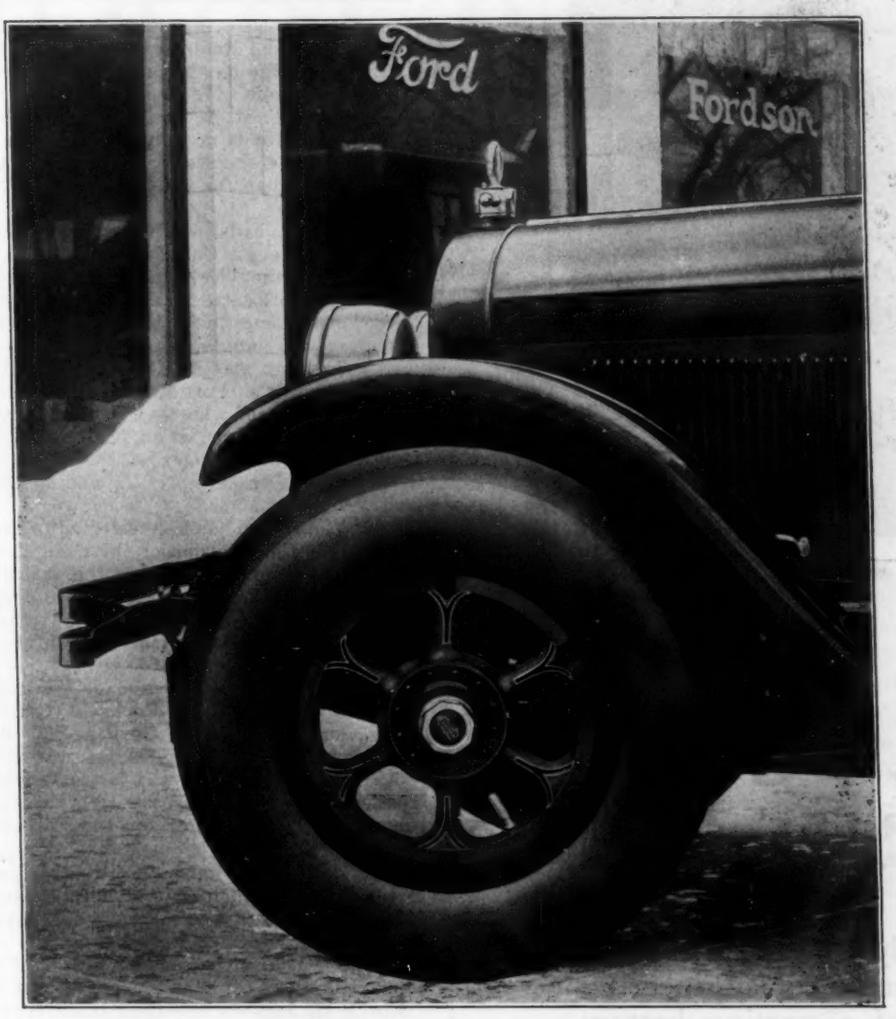
M. C. Dittmann has been appointed general manager of the Kirby-Davis Co., Philadelphia. Prior to this he was general sales manager for the Anderson Motor Co., Rock Hill, S. C.

H. L. Dunbar, who was formerly sales representative for the Vacuum Oil Co., New York City, has become affiliated with the Standard Oil Co. of Indiana, Peoria, Ill.

James L. Edelen has accepted a position as salesman for the Stromberg Motor Devices Co., Detroit.

James A. Edwards, who until recently was superintendent and automotive lubrication engineer for the Associated Oil

(*Continued on p. 4*)



CLASS, STRENGTH AND DURABILITY, ROUNDNESS AND TRUENESS possessed in the SMITH EXPANDED AUTOMOBILE WHEEL, for balloon and standard sized tires are incomparable and non-competitive.

We are makers of approximately 70% of all metal truck wheels made and sold in America. Our new line of light, speed truck pneumatic wheels is also fast coming to the fore.

Smith Expanded Wheels help sell motor vehicles, whether passenger cars or trucks. They are the wheels of the future!

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Not only the characteristics that a motor car engineer *demands* of a starting battery, but the little refinements that he *would demand* if he knew how much they improved its performance—that is what the automotive engineer obtains in Exide Batteries.

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PERSONAL NOTES OF THE MEMBERS

Continued

Co., San Francisco, has been made chief lubrication engineer for the Marland Refining Co., Ponca City, Okla.

J. G. Eldridge has become affiliated with the Cecil R. Lambert Co., Detroit. He was previously designer and field engineer for the C. M. S., Inc., Tarrytown, N. Y.

Henry Factor is no longer engaged in production work for the Wright Aeronautical Corporation, Paterson, N. J., but has become salesman for the H. Weinthal Auto Supply Co., New York City.

Clarence M. Foss, who was formerly chief engineer for the Walker M. Levett Co., New York City, has been appointed assistant to the vice-president of the General Motors Corporation, also located at New York City.

Archer Gibbons has accepted a position as manager for the T-Square & Triangle Co., Newark, N. J. His previous business connection was in a similar capacity with the Standard Office Service Co., Port Richmond, Staten Island, N. Y.

J. E. Gramlich, who was formerly chief engineer for the Watson Truck Corporation, Canastota, N. Y., has been appointed general manager of the Steam Vehicle Corporation of America, Syracuse, N. Y., and is located at its Stanley plant, Newton, Mass.

G. B. Gunlogson has been selected to head the newly created Case Motor Car Division of the Case Threshing Machine Co., Racine, Wis., and will perform the duties of sales manager of that division. For 14 years Mr. Gunlogson has been associated with the Case company in various capacities, more recently as research engineer and in charge of sales promotion and advertising.

F. W. Gurney has been made chairman of the board of directors of the Marlin-Rockwell Corporation, Jamestown, N. Y., successor to the Gurney Ball Bearing Co., also of Jamestown, of which Mr. Gurney was chief engineer.

A. A. Gustafson, who was formerly works manager for the Yellow Sleeve Valve Engine Works, East Moline, Ill., has become factory manager for the Fairfield Mfg. Co., Lafayette, Ind.

P. F. Hackethal, until recently chief engineer of the Fox Motor Co., Philadelphia, is now consulting and research engineer for the Maedler Syndicate, Cleveland.

William G. Harrsch has severed his connection with the Highway Truck Corporation, Chicago, of which he was president. His plans for the future have not been announced.

Elwell R. Jackson has been transferred from the Clinton, Iowa, office of the Climax Engineering Co. to the Cleveland office of that company, where he will hold the position of commercial automotive engineer in charge of that office and the outlying territory.

Lloyd P. Jones has been elected president and **David W. Rodger** secretary of the newly organized Federal-Mogul Corporation, Detroit, which is a merger of the Federal Bearing & Bushing Corporation and the Muzzy-Lyon Co., also of Detroit. Mr. Jones was formerly president of the Federal Corporation, while Mr. Rodger was secretary and director of sales of the Muzzy-Lyon Co.

Cosby King, who was previously chief engineer for the Scheel Motors Co., St. Louis, and more recently affiliated with the Haynes Automobile Co., Kokomo, Ind., doing work in connection with layout and designing, has accepted a position with the Perrot Brake Corporation, South Bend, Ind.

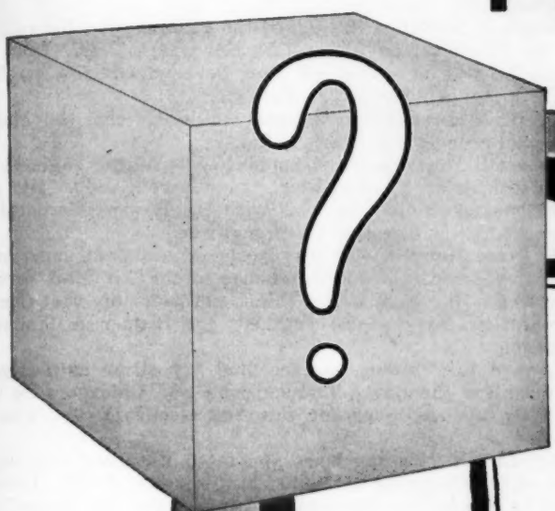
Jesse L. Larson has been appointed production manager and superintendent of factory for the Nolan Truck Co., Okay, Okla. Prior to this he was factory superintendent for the Oklahoma Auto Mfg. Co., of that city.

On April 24 **C. Y. Liu** sailed from San Francisco for China, to join the Reliable Engineering & Supply Co., Chengchow, Honan, China, of which he is a partner. While in the United States he completed the training course in student engineering with the Continental Motors Corporation, Detroit, and spent considerable time in investigating the business conditions in the Eastern part of the Country.

J. F. Loop has accepted a position with the Oakland Motor

(*Concluded on p. 6*)

Would You Buy Piston Rings Without a Name



Of course you wouldn't—and yet what difference does a name make unless it is a guarantee of everything you require of piston rings for more power, a saving in gas consumption, greater resiliency, and a smoother running engine?

For there is as much difference in piston rings as there is difference in the experience, knowledge and manufacturing facilities of piston ring makers.

The 125,000,000 **QUALITY** Piston Rings that have been put to work during the past 12 years, have through continued performance made **QUALITY** Rings the recognized standard for initial installation.

The Piston Ring Company

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The tradename **QUALITY** which is stamped in each ring, was selected as the only word suitable to fully express the actual values in each ring that bears this name.

"NORMA"
PRECISION
BALL BEARINGS

For Lighting Generators
and
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A motor car or truck is simply an assembly of mechanical parts functioning together to a common end.

When all function properly, car or truck performance is satisfactory. But if one part—however small—fail in its functioning, the combined merits of all the other parts cannot make good the defect.

Cars and trucks with magnetos and lighting generators equipped with "NORMA" Bearings, are safeguarded against one of the most common faults in electrical equipment—bearing trouble.

Service records prove that magnetos and lighting generators with "NORMA" Precision Ball Bearings run more quietly, last longer.

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PERSONAL NOTES OF THE MEMBERS

Concluded

Car Co., Pontiac, Mich. He was formerly assistant engineer in the tractor works of the Moline Plow Co., Moline, Ill.

Albert A. Lyman, who was previously chief engineer at the Marion, Ind., engine plant of the Velie Motors Corporation, Moline, Ill., is now associated with the Yellow Sleeve Valve Engine Works, East Moline, Ill.

James J. McMahon has joined the general sales department of the International Motor Co., New York City. Until recently he was in charge of sales development for the Bannister Motor Appliance Co., Pittsburgh.

M. H. Medwedeff has become affiliated with the Marion Forged Products Co., Marion, Ind.

Robert I. Miner has been appointed consulting engineer for the Youngstown Pressed Steel Co., Warren, Ohio. His previous business connection was with the Bossert Corporation, Utica, N. Y., as assistant chief engineer.

E. Tasso Morgan, who was formerly assistant superintendent at the repair depot warehouse of the Air Mail Service, Maywood, Ill., and later chief engineer of the Conlow Corporation, has become engineer for Bruner & Simmons, Chicago.

Edward L. Peterson has accepted a position as designing engineer for the Bovee Transmission Co., Chicago. He was formerly tool designer for the Addressograph Co., also of Chicago.

William D. Pile has been appointed service-station manager of the Cumming & Dillon's Autoservice, Dublin, Ireland. Prior to this he was automobile engineer for the Clanwilliam Motor Co., also of Dublin.

Wynn F. Rossiter has become affiliated with the Carpenter Steel Co., Hartford, Conn. He was previously salesman for the Crucible Steel Co. of America, New York City.

Frank J. Sikorovsky, who was formerly divisional superintendent in the tool department of the American Car & Foundry Co., Chicago, has accepted a position as superintendent with the Ampco Twist Drill & Tool Co., Detroit.

P. A. Tanner, who for the past 2½ years has been vice-president and sales manager of the Johnson Motor Co., South Bend, Ind., has resigned. He has not yet announced his plans for the future.

Theodore P. Thomas has joined the experimental department of the Packard Motor Car Co., Detroit.

John M. Walter, whose previous business connection was mechanical engineer with the Ahrens-Fox Fire Engine Co., Cincinnati, has become layout draftsman for the O. Armleder Motor Truck Co., also of Cincinnati.

Walter B. Wessells, who was formerly manager of the Mountain States Roofing Co., Denver, has been appointed tester on installation work for the Western Electric Co., Chicago.

P. E. West, assistant technical advisor of the General Motors Export Co., New York City, is making an extended trip through South America.

John M. Williams, Jr., is no longer assistant chief engineer for C. H. Matthiesen, Jr., Inc., Long Island City, N. Y., but is now associated with the Vacuum Oil Co., New York City.

Raymond C. Wilson has severed his connection with the Fergus Motors of America, Inc., Newark, N. J. His plans for the future have not been announced.

C. L. Wood has severed his connection as chief engineer for the Federal Motor Truck Co., Detroit. His plans for the future have not been announced.

H. Putnam Wood has become draftsman for the Seaman Body Corporation, Milwaukee. He was formerly engaged in body designing for the Racine Mfg. Car Division of the McCord Co., Racine.

Benjamin F. Wright has been appointed manufacturer's representative for the Spencer-Smith Machine Co., Howell, Mich. He was formerly designer and layout draftsman for the Timken-Detroit Axle Co., Detroit.

James C. Zeder, who was formerly service engineer for the Timken Roller Bearing Co., Canton, Ohio, is now located at the Chrysler plant of the Maxwell Motor Corporation, Detroit.

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In cars all along the price range

IT is significant that Thompson Silcrome Valves are standard equipment in cars, trucks and tractors all along the wide American price range.

The moderate cost of the Thompson Silcrome Valve makes it available to car builders in the intensely competitive classes of the industry. At the same time its unequaled ruggedness has won the approval of engineers who need consider nothing but performance in the selection of a vital motor part.

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Bock "R" Type

Bock Bearings of the R type have made an outstanding record for continuous service without failures. The strong one piece cage appeals to engineers and service men alike as a mechanically perfect unit.

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ENGINEERS and service men know that the Bock "R" Type Bearing, introduced over two years ago, gives extraordinary service. Failures are almost unheard of. But for certain applications it has not been available and its use therefore was limited.

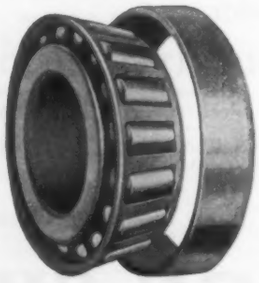
The new Bock design, the "D" Type, increases the range of sizes and applications enormously. The same quality chrome nickel steel, double heat treated; the same consummate workmanship; even the round head roller design in modified form; with these features Bock Quality is maintained in the new D type. In actual service for several months these bearings have proved 100% satisfactory.

Whether you find the R Type or the D Type best suited to your needs, you will find the use of either of these reduces bearing troubles to the absolute minimum.

THE BOCK BEARING COMPANY
Toledo, Ohio

"D" Type

This latest Bock design has been developed for the narrower sizes and for certain special applications. Engineers who have tested it are enthusiastic over the wider use of Bock "quality" thus made possible.



BOCK

***Quality* TAPER ROLLER BEARINGS**

Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

SOME NOTES ON FOUR-WHEEL BRAKING SYSTEMS. By F. A. Stepney Acres. Published in preprint form by Institution of Automobile Engineers; 20 pp.

The author of this paper is strongly in favor of fitting brakes to all wheels. After mentioning the fact that if the difficulties of front-wheel brakes are not boldly faced by designers and builders, front-wheel brakes may once more be classed among the failures, he states that the principal dangers alleged against front-wheel brakes are risk of front-wheel skid, risk of front-spring failure and disturbance of the steering-gear due to brake effort. Certain mechanical difficulties are also named, such as lack of rigidity of the front axle, the nature of its movements when the brakes are applied and the fact that front springs are almost invariably anchored at the forward end; and the opinion is expressed that the greatest danger of all is the thoughtless and incompetent driver. The objections to four-wheel systems are dealt with very briefly in an introductory section, and the main portion of the paper is devoted to a consideration of the question of grouping and operation.

The three main groups into which four-wheel brakes are divided are the following: independent, semi-independent and coupled. In the first two groups the question arises as to whether the front brake should be included in the service system or not. The following objections are urged against so including it:

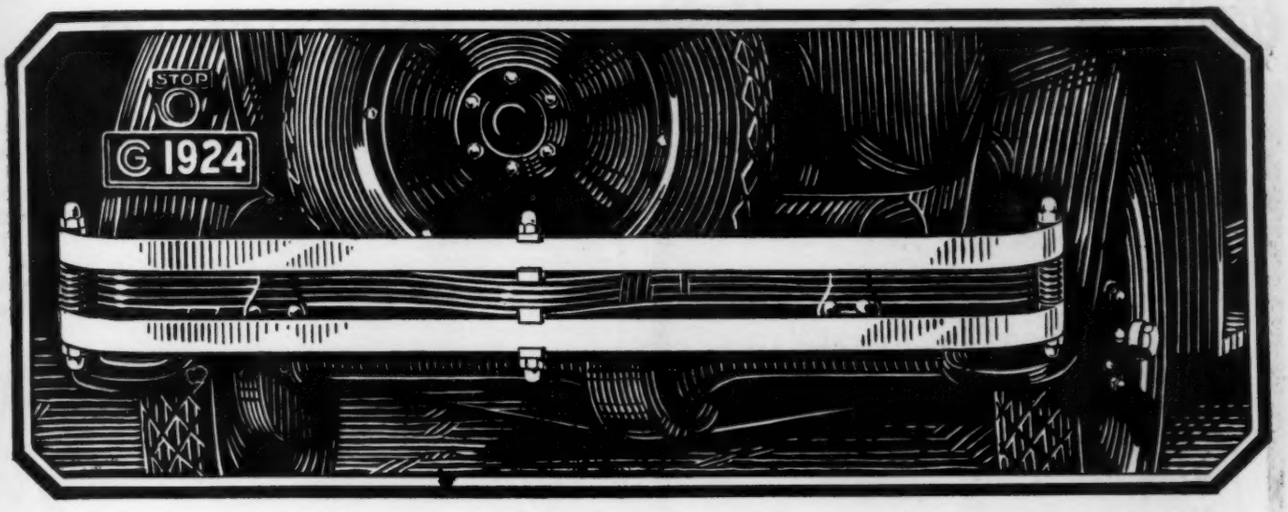
(1) The rear-wheel brake is capable of doing all the work normally required of a service brake
(2) Very few drivers are accustomed to anything other than a rear-wheel brake
(3) Injudicious use of brakes is generally more disastrous in the case of front-wheel brakes than of rear-wheel brakes
(4) A rear-wheel skid can be corrected, while a front-wheel skid cannot
(5) The foot-brake is much more liable to injudicious or violent application than the hand-brake
(6) Any front-axle or front-suspension failure is much more serious than a rear-axle or suspension failure of the same kind, and therefore while the front axle must be well up to its load, it should not be compelled to take that load more often than necessary

Realizing that the above objections to including the front brake in the service system might easily be offered as objections to four-wheel brakes themselves, the author stresses as the reason for their adoption the fact that they give greatly increased stopping power in an emergency.

The other group of brakes, the coupled, is described as the true four-wheel brake system; it includes the so-called six-brake system and is considerably more expensive than the independent, since it calls for an additional brake on the rear wheels or the transmission and in many cases for some form of servo gear.

In connection with the coupled brakes, brake-power ratio is discussed at some length. This ratio of the braking power exerted at the front wheels to that exerted at the rear wheels has, in a coupled system, a fixed value in any given vehicle, dependent solely on the relative sizes of the brake-drums, the leverage ratios and the like, and it has a very large bearing on the behavior of such a system under varying conditions. Stating as axiomatic that in any four-wheel braking system, application of the brakes under all conditions shall never lock the front wheels before the rear ones, the author

(*Continued on p.* 10)



What is a Good Bumper?

By the Car Owner:

"It must improve the appearance of my car, as well as give me adequate protection against collision.

"It must protect the fenders of my car as well as the radiator.

"It must not rattle nor work loose from its fittings.

"It must not rust, nor keep me busy with the polishing rag.

"And it should be considerate of my pocket book."

C. G. SPRING BUMPERS
DO THESE THINGS

By the Distributor:

"It must be attractive in appearance and price.

"It must be easy to install on my customer's car.

"It must be adaptable to any make of car that I handle.

"It must be equally adaptable to all types of support arms so that I need not carry a large stock.

"It must be of a quality, both of workmanship and finish, such that I shall have no complaints from my customers."

C. G. SPRING BUMPERS
ARE LIKE THAT

By the Car Manufacturer:

"It must be in accord with the design of our car and enhance its value in the public eye.

"It must be adapted to quantity production so that we shall never be held up on deliveries.

"It must have a finish, both in nickel and enamel, which is comparable to the fine quality of nickel plating and enamel on our own product.

"It must lend itself to rapid assembly in our production line-up.

"It must be inexpensive."

C. G. SPRING BUMPERS
FIT ALL CARS

By the Engineer:

"It must absorb a collision shock with the maximum deflection possible.

"It must inflict the minimum amount of distortion on the supporting arms.

"It should be strong enough to resist all but the heaviest collision blows without permanent distortion of the impact bars.

"It must be so securely anchored to the car frame that it becomes a part of the chassis.

"It must be of heat treated spring steel of the thinnest possible section compatible with requisite strength.

"And it must be of light weight."

C. G. SPRING BUMPERS
HAVE THESE QUALITIES

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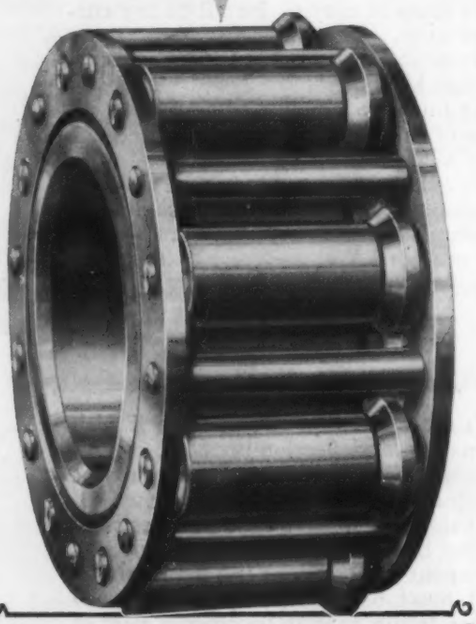
BOWER SAVES POWER

CARRIES THE LOAD
TAKES THE THRUST

The little slogan, "Carries the load—takes the thrust," in a very simple way explains one of the secrets of the great staying qualities of the Bower Roller Bearing.

We would like to explain further the many other superior points of this well known bearing, which continue to interest so many of the well known automobile manufacturers. May we?



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ROLLER BEARING CO.
Detroit · Michigan

BOWER SAVES POWER

NOTES AND REVIEWS

Continued

considers the point of brake-power ratio to be of primary importance if four-wheel systems are to be popular and safe in the hands of inexperienced drivers.

With reference to the production of a thoroughly satisfactory front-wheel brake, it is stated that the difficulties are purely mechanical and by no means insuperable. The tendency of a brake to chatter or shudder is discussed in some detail. The questions of pedal leverage, central steering, compensation, front springs and brake-rod lay-out are also considered.

In conclusion, the author reiterates his approval of four-wheel brakes and expresses his preference for the independent system as being lighter, less complicated, cheaper and at the same time more efficient than the coupled system.

DIFFICULT PROBLEMS INVOLVED IN POWER BRAKING FOR MOTOR VEHICLES. By P. M. Heldt. Published in *Automotive Industries*, March 13, 1924, p. 618, and March 20, 1924, p. 656.

In the two sections of this article, the history of power braking in this Country is traced, reasons are outlined for the present interest in the subject and descriptions are given of the Westinghouse airbrake for road vehicles and for motor rail-cars and the Simplex vacuum brake for passenger cars and trucks. Some of the difficulties involved in the design of efficient power-braking systems are pointed out, and the matter of overcoming the tendency to jam is said to be one of the important problems confronting the designer of power brakes.

CONTINUOUSLY VARIABLE TRANSMISSION DEVELOPED IN AMERICA. Published in *Automotive Industries*, March 20, 1924, p. 674.

A continuously variable transmission is described that has a driving member in the form of a hemispherical shell within which is a body known as a mutor. The mutor is of ring, wheel or disc form and is adapted to rotate around its axis on an anti-friction bearing. It is claimed that with this gear it is possible to bring a car to a stop on a hill and hold it without applying the brakes and without shutting down the engine.

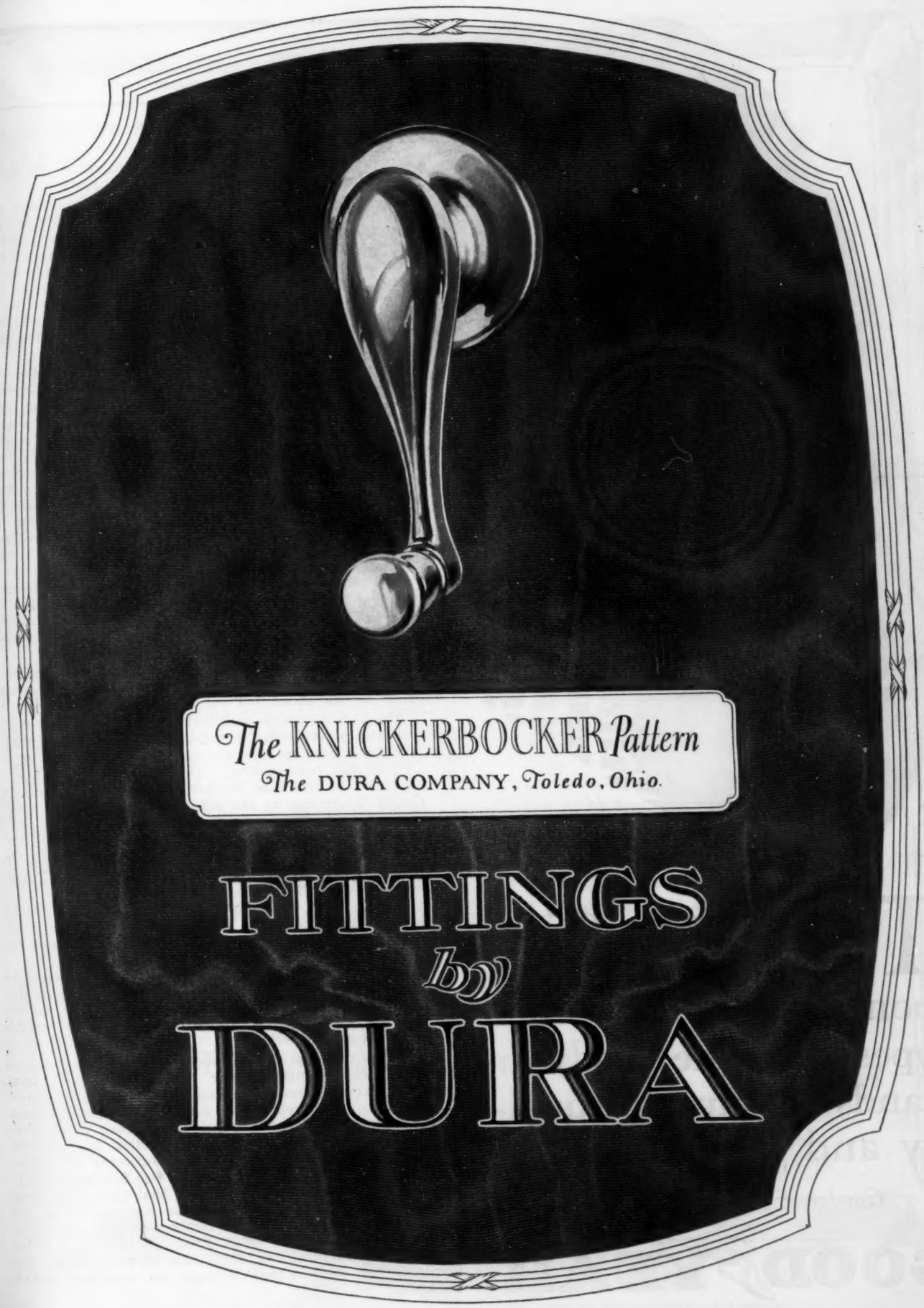
NOVEL GEAR-SHIFTING MECHANISM CHIEF FEATURE OF GERMAN BUS. By Benno R. Dierfeld. Published in *Automotive Industries*, March 6, 1924, p. 575.

Original design features that are incorporated into a new bus chassis are discussed and illustrated in this article. A description of the gear-shifting mechanism includes the following points. The gear lever, guided in the gate in the usual manner, is adapted to swing laterally around the pivot on the trunnion. The trunnion, which oscillates with the lever in the housing, contains a bearing for the shifter arm. The lever and the arm are connected by a link within the trunnion. The principal advantage claimed for this construction is that in shifting gears only oscillating or rotary motions occur; sliding motions are obviated and no sticking of the parts can occur.

A device is described that has been developed to prevent swaying of the rear end of the body. On top of the differential-gear housing is mounted a double-armed lever that normally extends fore and aft. From the ends of this lever, links with universal connections extend to the two side members of the frame. As the springs deflect and rebound, the distances between the ball joint on the differential and the joints on the frame vary, and this variation is taken care of by swinging the lever around its fulcrum. It is obvious, however, that since the two links remain of the same length and the transverse motions of the ends of the lever are the same, the distances between the fulcrum axis and the frame side-members must always remain the same, and therefore no swaying can occur.

Other features of the design are a novel method of locking the shifter bars and a new type of front axle for which the

(*Continued on p.* 12)


The KNICKERBOCKER Pattern
The DURA COMPANY, Toledo, Ohio.
FITTINGS
by
DURA

TODAY—as in the years past—on Balloon Tires as on all other types, the name *Goodyear* stands for supreme quality and dependability.

Goodyear Means Good Wear

GOODYEAR

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NOTES AND REVIEWS

Continued

advantage is claimed that the steering pivot operates constantly in a bath of oil.

VARIABLE TRANSMISSION. By G. Constantinesco. Published in *Automobile Engineer*, February, 1924, p. 39.

In the fourth article of the series, Mr. Constantinesco discusses the principles of his converter with reference to various types of automobile. The point is stressed that when a converter is designed for a car, the type of work to be done by the car in question must be predetermined. If the transmission has been designed for racing purposes, the car will prove uneconomical when running at low average speeds; if, however, the transmission be designed to give economical running, the car will show to a disadvantage for racing purposes.

To illustrate the respective merits of the converter and the orthodox gear, several comparisons are made between similar cars fitted with the two types of transmission. An orthodox car that has a variation in the gearbox of 4 to 1 is compared with a similar car using the same size of engine but having a converter instead of a gearbox, and the performance of both cars is shown to be very much the same. The extreme speed and the steepest-hill test will be exactly the same. Some intermediary hills will be climbed faster by the orthodox car and some faster by the converter car. A converter car and a three-speed gearbox car are compared and the advantage is shown to lie with the converter car. A comparison between a car fitted with the converter and a similar car fitted with an infinite number of gears positively controlled gives results favorable to the latter, if the latter is so skillfully controlled that the change is made instantly and without any hesitation to provide the exact gear-ratio corresponding to the resistance encountered by the car.

The chief advantages of the converter as shown by this article lie in its economy in running and in its automatic control. In this connection the author says:

> Although it appears paradoxical, the penalty of economy and automaticity is the obstinacy of the engine in never departing from the conditions set by the design of the transmission. The driver may be disappointed to find that the performance of his car is rigidly determined by the automatic transmission, but he must content himself with the behavior of the car as predetermined by the designer.

GRUNDLAGEN DES AUTOMOBILBAUES (Principles of Automobile Construction). By W. Ghittis. Published by M. Krayn, Berlin. 134 pp.; 108 tables; 98 illustrations.

This work is of an analytical nature, supplemented by a vast amount of tabulated experimental data. The treatment deals with the motor car as a whole and also with the sub-assemblies in their various types.

Among the subjects pertaining to the entire car are the forces that oppose car motion and their effect upon engine torque; car stability, both on straight roads and on curves; car vibration resulting from rough roads and the gyrostatic action of the road wheels.

The component units of the motor car are handled in a thoroughly fundamental manner. In the engine, the principles of thermodynamics, mechanics, carburetion and cooling, together with problems of construction, are discussed. In the analysis of clutches are included the cone, the expanding and the contracting band, the expanding shoe and the multiple-disc types. Change-speed mechanisms of the sliding gear, planetary gear, cone friction and disc friction varieties are presented. In the analysis of the final drive is included a treatment of the chain drive, the universal-joint, the propeller-shaft and all possible combinations of means for transmitting the tractive effort from the rear axle to the chassis and of resisting the torque reaction at the axle. The kinematics of steering-gear linkages are analyzed mathematically.

(*Continued on p.* 14)

Announcement of Consolidation

The Federal Bearing & Bushing Corporation and the Muzzy-Lyon Company, both having felt the tremendously increasing demand for their products year after year, and both having enjoyed the greatest year in their histories during 1923, now in the sincere desire to even better cooperate with their many friends throughout the industry have deemed it wise to join forces.

The immediate advantages of this merger to the large list of manufacturers using Mogul and Federal products are many.

By adopting the very best ideas, manufacturing practices, and processes from both plants—increased production, economy, and finer quality are sure to follow.

To everyone in the industry, Mogul stands for the best obtainable in bearing metals, and Federal-Detroit immediately brings to mind Quality in Bronze. Here is a bringing together of two specialists—one in babbitt, and one in bronze.

It gives a complete line of products under one able management and one expert supervision. The added strength resulting from this consolidation of interests and consequent elimination of much duplicated overhead in every way works toward the best interests of the customers of both organizations.

It gives a million dollar source of supply with greatly expanded facilities for high quality and quantity production at fair prices on—

Bronze Back Babbitt-lined Bearings.
Standard—Close-limit Interchangeable—Radiated.
Die Cast Babbitt Bearings and Bushings.
Bronze Bushings and Bronze Washers.
Bronze Castings.
Bronze Cored and Solid Bars.
Babbitt Metals.

The old established trade-marks, known throughout the entire country will be continued, and combined in the new trade-mark and corporate name.

New Board of Directors and Officers

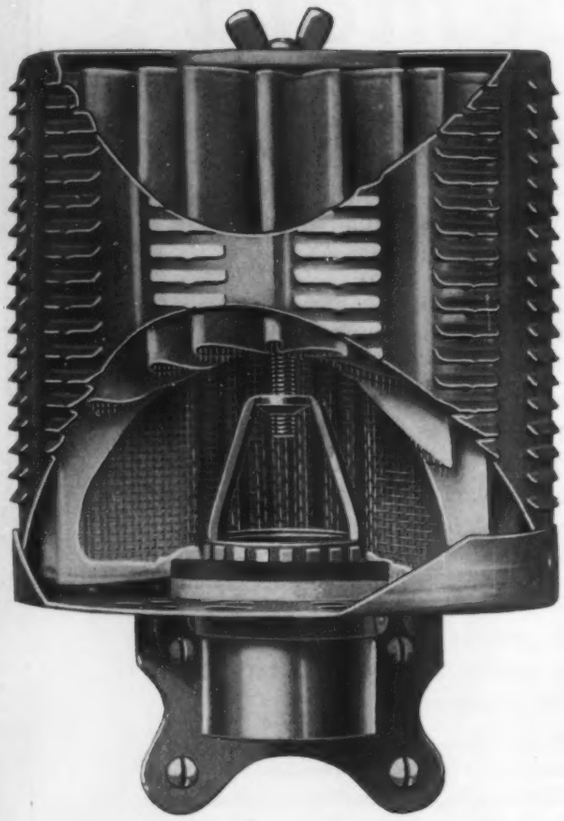
J. H. Muzzy, Chairman — Lloyd P. Jones, President — H. Gray Muzzy, Vice-President
David W. Rodger, Secretary — S. C. Reynolds, Treasurer
H. W. Grant — F. C. Heath — C. R. Murphy

FEDERAL-MOGUL CORPORATION

DETROIT, U. S. A.

Mogul FEDERAL

PROTECTOMOTOR
REG. U.S. PAT. OFF.
Perfect Positive Protection



The only device that offers *real* protection to a motor against damage caused by road dust, sand and grit.

Does not offer appreciable restriction or decrease in power.

More than 99 9/10 efficient under any and all conditions.

Installed as standard equipment by General Motors Truck Company, International Motor Company, Fageol Motors Company, J. I. Case Threshing Machine Company, Holt Manufacturing Company, Clark Tructractor Company, Bean Spray Pump Company, Le Roi Engine Company, Elgin Street Sweeper Company, Turner & Moore Engine Company.

Staynew Filter Corporation
ROCHESTER, N. Y.

BRANCHES:
1926 Broadway, New York City; 403 Real Estate Exchange Bldg., Detroit, Mich.; 222 Henshaw Bldg., Oakland, Calif.; 1031 Cathedral St., Baltimore, Md.

NOTES AND REVIEWS

Continued

A valuable feature of the work is a bibliography that lists 114 books and 37 periodicals dealing with automotive subjects.—H. A. H.

HOW INTERNAL LOSSES IN POWERPLANTS VARY WITH SPEED. By P. M. Heldt. Published in *Automotive Industries*, March 6, 1924, p. 556.

A friction-horsepower curve, measuring internal losses in a gasoline engine, is obtained by "motoring" the engine by an electric dynamometer; the torque on the field frame of the dynamometer then indicates the friction torque. The torque measured under these conditions represents both the various mechanical-friction losses and the pumping losses. The latter, defined as the losses occasioned by gas pressure on the piston contrary to its direction of motion, are described in this article, and the various items that compose the mechanical-friction losses are analyzed.

Tests have been made in which an engine is motored first completely assembled and with the throttle wide-open and then with all of the valves and the plugs removed from the cylinders; the difference between the torques required to turn over the engine under these two conditions represents the torque due to the pumping losses. From the tests it has been determined that no material difference in friction is apparent whether the engine is idling or under load and that torque representing pumping loss is directly proportional to the speed but that frictional loss is independent of the speed.

THE DESIGN AND PERFORMANCE OF COMPLETE CYLINDRICAL BEARINGS FROM MATHEMATICAL THEORY OF LUBRICATION. By G. B. Upton. Published in *Sibley Journal of Engineering*, March, 1924, p. 56, and April, 1924, p. 97.

The author refers to a paper by H. A. S. Howarth, entitled A Graphical Study of Journal Lubrication, which was published in *Mechanical Engineering*, February, 1924. The mathematical basis for Mr. Howarth's study was an analysis by W. J. Harrison, and the present paper is a discussion of Howarth's application of Harrison's mathematical work.

It is stated that Harrison's analysis is derived for an infinitely long bearing, that is, one in which "end leakage" is not a factor as it is in all actual finite bearings; hence, Harrison's findings will not be applicable to actual bearings, in a numerical way, until some method is found of properly altering the equations to take care of end leakage, or the lengthwise variation of pressure in the oil-film of the actual bearing as contrasted with the constancy of pressure lengthwise, postulated by Harrison.

The paper is divided into two general parts: first, the presentation and the discussion of Harrison's equations; second, the modifications brought about by finite length and its consequences in end leakage of the lubricant and lengthwise variation of the pressure in the lubricating film.

ACHIEVING SAFETY IN LUBRICATION. By R. W. A. Brewer. Published in *The Iron Age*, March 20, 1924, p. 857.

This article discusses the tests made and the conclusions reached with regard to a method of improving lubricating oils by the addition of fatty acids. Such addition is said to result in the formation of a very thin film on the surfaces of the metals in contact, and this boundary film is believed to prevent the seizure of heavily loaded bearings, to reduce the coefficient of friction and to make possible the use of lubricants of a lower viscosity than is generally supposed to be satisfactory.

TRUCKS, TRUCK BODIES AND TRANSPORTATION. By Matthew W. Potts. Published in *Industrial Management*, March, 1924, p. 151.

Calling attention to the fact that motor-truck transportation has developed so rapidly that today the commercial value of this system has advanced beyond the knowledge of the proper way to use such equipment, the author mentions

(*Continued on p.* 16)

Another Milestone in Automotive Design

The permanently silent motor has been, in the past, an ideal to which car manufacturers and automotive engineers alike have aspired. Today every motor car manufacturer can accomplish this aim.

The advent of the non-metallic camshaft and idler gears proved the theory that the vast majority of engine noises develop in the timing gear train. Prompted by the need of a noiseless gear combining strength, elasticity, and durability with adaptability to highly accurate cutting and machining, the General Electric Company has developed the Textolite Gear, built of interlocking layers of impregnated cotton fabric. This gear has proved its superiority in rigid tests and on cars in actual service.

Records of installations have already demonstrated that Textolite Gears not only outwear the metal gears previously used for such service but retain their silent quality and add materially to the life of the entire engine.

Descriptive literature and service data may be obtained from any G-E office.

The following well-known motor cars are factory equipped with Textolite Timing Gears:

Kissel
Locomobile
Marmon
Stevens
Velie

and others whose manufacturers prefer to make their own announcements.

Textolite Gears can be obtained as replacement for nearly every car using gears in the timing assembly.

General Electric Company
Schenectady, N. Y.

Sole distributor to the Service Trade:
John C. Hoof & Company
157 West Illinois St., Chicago, Ill.

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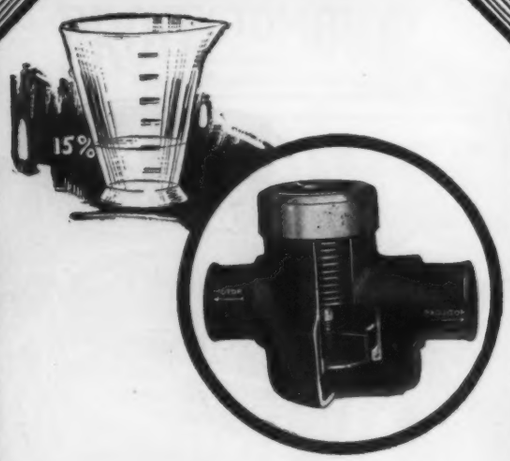
GENERAL ELECTRIC



These cars are saving 15 to 20% Gasoline

By carrying Sylphon Automobile Temperature Regulators as standard equipment to control the temperature of the cooling medium, all these cars are not only saving 15 to 20% in gasoline consumption, but they are reducing the wear of valves, pistons and cylinders and greatly reducing crank case dilution and carbon deposits.

AMERICAN:	FOREIGN:
Cadillac	Fiat
Cunningham	Lanchester
Lafayette	Leyland
Lincoln	Napier
Packard	Rolls-Royce
Paige-Detroit	Straker-Squires
Pierce-Arrow	Vauxhall
Premier	

TRUCKS:
American-LaFrance Ward La France
and many other cars and trucks

Sylphon Automobile Temperature Regulators have but three main parts: a seamless Sylphon Bellows; a valve and a housing for the Sylphon.

The Sylphon is filled with a volatile liquid, which vaporizes at a predetermined temperature, expanding the Sylphon and opening the valve to admit water, and contracting and closing the valve when temperature falls.

The Sylphon Automobile Temperature Regulator is self-regulating, adaptable to pump or thermo-syphon cooling systems. Can be installed between the radiator and the engine, either in outlet or inlet water connection.

Send for Bulletin JUR

Illustration shows Sylphon Automobile Temperature Regulator as installed on Napier

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New York Chicago Detroit Boston Philadelphia

Representatives in all principal cities in U. S.

NOTES AND REVIEWS
Continued

among the defects that are responsible for many inefficiencies in truck operations, (*a*) the insufficient use of auxiliary equipment to facilitate the loading and the unloading of trucks and (*b*) unsuitable bodies. The trailer is named as a means of keeping the truck continually under load and on the move and is discussed under the four general types: (*a*) four-wheel trailers, (*b*) two-wheel trailers, (*c*) semi-trailers and (*d*) pole or pipe trailers. Where the use of trailers is not possible, demountable bodies are advocated.

Motor-truck transportation, it is stated, can hardly be considered as a separate entity, for its very existence is interwoven with that of the waterways and the railways, and its future will of necessity be influenced by them. Expressing the opinion that the potency of the motor truck will ultimately force railroad executives to adopt and use it as an adjunct to their present facilities, the author concludes his paper with the statement that it is necessary for progressive plant executives to understand the true value of the motor truck and its proper place in the national transportation system, so that they will be prepared for the new conditions that will shortly exist.

BUILDING AND MAINTAINING A FLEET OF TWENTY-FIVE INTERCITY STAGES. Published in *Bus Transportation*, April, 1924, p. 151; 7 illustrations.

A description is given of the equipment and methods of a California company that operates 19 buses on regular schedule with 6 extras, and in addition builds a new car each month.

FOUR DIFFERENT TRACTOR TYPES DEVELOPED FOR USE IN ROADLESS AREAS. Published in *Automotive Industries*, April 10, 1924, p. 820.

This article refers to a paper read recently by L. A. Legros before the British section of the Société des Ingenieurs Civils de France. Four widely different types of tractor that have been worked out for use in rough and roadless country are discussed, the four types being as follows:

(1) The Armstead snow-motor of American construction appears to be an original method of solving the problem of transport over large snow-covered areas, but it is specialized for running on snow and ice

(2) The Pavesi jointed tractor, of Italian origin, offers a very original solution of the problem of arranging a vehicle to be proof against any distortion caused by subjecting the axles to certain stresses and capable of crossing sand and the roughest country

(3) The Kegresse tractor or truck, of French design and make, which is an ingenious improvement on the jointed chain-track; a machine that can cross snow and ice, sand and marsh, rough country and run on the road, a machine that is as much at home on the snow of the Alps as on the sands of the Sahara and has the distinction of being the first to cross the full width of the Sahara

(4) The multi-wheeled vehicle, of which type the Renault is an example. This design, based on the suggestions of General Estienne, was produced with the object of facilitating exploration and route-locating in the Sahara, and it has demonstrated its capacity for long-distance exploration

Topics treated in the paper include the following: principal obstacles to traction, stability of four-wheel tractor, the two-wheel tractor, two-wheel versus four-wheel steering, general features of the cross-country tractor and the number of differentials required.

(*Continued on p.* 18)

A Pneumatic Tire built Expressly for Commercial Cars

The Goodrich Heavy Duty Cord. Massive, rugged, durable.

It has a scientifically designed anti-skid tread of tough, wear resisting rubber.

A newly developed sidewall construction reinforced with sturdy ribs of rubber provides extra protection against curb and rut chafing.

You have only to see it, to know that it is the pneumatic tire the commercial car has needed. Ask a Goodrich Truck Tire Distributor to show it to you.

THE B. F. GOODRICH RUBBER CO.
ESTABLISHED 1870

Goodrich
Heavy-Duty CORD
"Best in the Long Run"

Acme Wire

The slightly higher cost of Acme Wire is returned to you many times over in the increased output of winders, the fewer rejected coils, and the longer life of windings.

Acme Wire stands as the result of constant research and endeavor to produce the very best wire tha. can be made for one particular purpose—winding coils.

From the beginning of the magnet wire industry, Acme has pioneered in the development of fine silk-and-cotton-covered enamel wire.

Acme men know winding requirements through years of actual experience with winding conditions, for in our own plant they wind hundreds of thousands of coils each year.

THE ACME WIRE CO., New Haven, Conn.
NEW YORK CHICAGO CLEVELAND

"It goes in the space"

ACME WIRE PRODUCTS

"Enamelite," plain enameled Magnet Wire; "Cottonite," Cotton-covered Enamelite; "Silkenite," Silk-covered Enamelite; Single and Double Cotton Magnet Wire; Single and Double Silk Magnet Wire. We also have a complete organization for the winding of coils in large production quantities.

ACME VARNISHED INSULATIONS

Varnished Cambrics, Silks and Papers, Varnished Tapes in rolls; straight or bias. Varnished Tubing (Spaghetti).

ACME RADIO SPECIALTIES

Audio Transformer windings; Radio Frequency windings; Magnet windings for Head Sets; Enameled wire—especially the finest sizes, 40-44 B & S gauge; Silk and cotton-covered magnet wire; Enameled Aerial wire, single wire and stranded.

Illustrated Catalog on request to Engineers, Purchasing Agents, Executives, and Operators.

NOTES AND REVIEWS

Continued

THE GIBBONS LANDING AND LAUNCHING DEVICE. Published in *Aviation*, March 24, 1924, p. 308.

A device that is claimed to solve the terminal problem of civil aviation, by permitting the landing and the launching of an airplane in a very short distance, consists of a flat, unobstructed platform made up of wood flooring on a light structural-steel framework. Its size is determined by the weight and the landing speed of the airplanes it is to handle, the smallest dimensions being about 60 ft. wide and 175 ft. long. The outstanding feature of the invention is the employment of various means for slowing up an airplane after landing, as a result of which a plane landing at 60 m.p.h., that would run between 600 ft. and 700 ft. when landing on an ordinary field, will run only 125 ft. on the landing platform. The airplane receives no severe shocks and no loads greater than it is calculated to take and requires no modification except that the tail skid should have a smooth metal shoe.

For commercial purposes these platforms may be located on office buildings, postoffice buildings, railroad stations and docks; they may also be used on shipboard. For military purposes they are applicable to coast defense, canal patrol or on board battleships.

AERODYNAMIC CHARACTERISTICS OF AIRFOILS. National Advisory Committee for Aeronautics Report No. 182. Published by National Advisory Committee for Aeronautics, City of Washington. 44 pp.

This collection of data on airfoils, which has been made from the published reports of a number of leading aerodynamic laboratories of this Country and Europe, is presented here in a uniform series of charts and tables suitable for the use of designing engineers and for purposes of general reference.

The absolute system of coefficients has been used. Each airfoil section is given a reference number, and the test data are presented in the form of curves from which the coefficients can be read with sufficient accuracy for designing purposes. The dimensions of the profile of each section are given at various stations along the chord in per cent of the chord, the latter also serving as the datum line. When two sets of ordinates are necessary, on account of taper in the chord or the ordinate, those for the maximum section, at center of span, are given on the individual-characteristic sheets, while those for the tip section are given in separate tables. Where the ratio of the ordinate to the chord remains constant, the one set of ordinates applies to both the center and the tip section. The shape of the section is also shown with reasonable accuracy to enable one to visualize more clearly the section under consideration, together with its characteristics.

FURTHER NOTES ON THE DESIGN OF WING SPAR SECTIONS. By Edward P. Warner. Published in *Aviation*, April 7, 1924, p. 358.

The author refers to an article published by him in 1922 in which he outlined a simple method of approximating to the sectional area required for a wing spar of a known depth and subjected to a known bending-moment and compression. The present paper discusses objections that have since been advanced concerning (*a*) the omission of any allowance for the effect of buckling of the spar and (*b*) the neglect of the form factor in selecting the allowable bending-stress to be used.

THE EFFECT OF SLIPSTREAM OBSTRUCTIONS ON AIR PROPELLERS. By E. P. Lesley and B. M. Woods. National Advisory Committee for Aeronautics Report No. 177. Published by National Advisory Committee for Aeronautics, City of Washington. 24 pp.; 5 tables; 15 illustrations.

This report describes an investigation to determine the effect of slipstream obstructions on air propellers. The screw

(*Continued on p.* 20)

BAKELITE

TRADE MARK REG. U. S. PAT. OFF.

THE SATURDAY EVENING POST

Submerged for six months in fifteen feet of water at the bottom of a quarry

Gentlemen:

We are writing you relative to the dependability of Delco equipment as brought to our notice recently.

In November 1923, a Hudson 6-45 car depreciated from Rutland, Vermont and was supposed to have been stolen. In May of this year this car was found in an abandoned quarry two miles south of this place in about fifteen feet of water. The water was being pumped out and the car was found at the level. The job of removing the car was given by us to [illegible] and we afterwards purchased it. The top and upholstery had rotted and we took the chassis and motor down for parts. We took the Delco starter and generator off completely and, after drying out the water in them experiment, connected a storage battery to the terminals and found that the armature responded immediately.

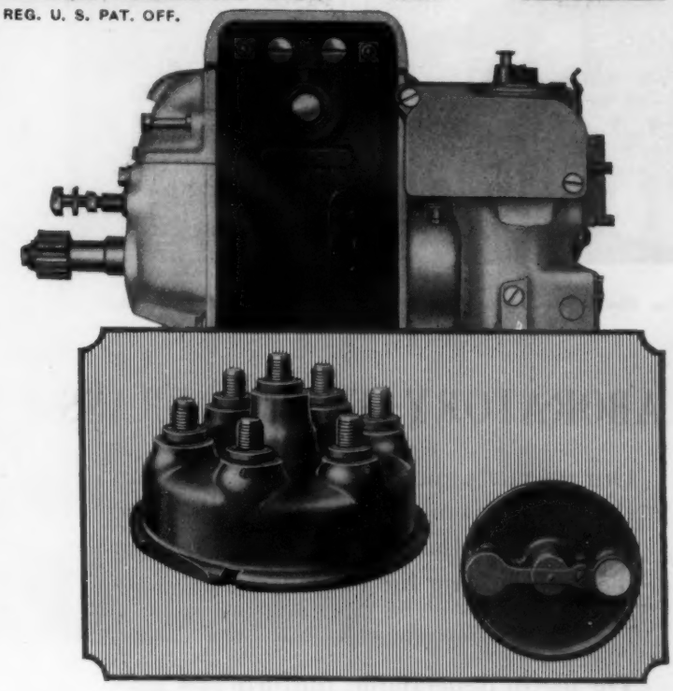
As a matter of curiosity we installed this starter and generator in another Hudson car and found that it worked absolutely perfect in every way.

Very truly yours,

H. B. [illegible]

Delco

STARTING, LIGHTING AND IGNITION



Conclusive evidence of stability

This unexpected test of Delco equipment was also a test of the resistant, dielectric, and mechanical strength of Bakelite—as the writer states, "we installed this starter and generator in another Hudson car and found that it worked absolutely perfect in every way."

This test is convincing evidence of the stability of Bakelite, the insulation Delco employs in important parts to assure positive functioning of the complete unit.

In addition to the many other valuable properties of Bakelite, its dependability in molded, laminated, or other form, is an outstanding characteristic of this unique material.

Perhaps you would like to know more of this "Material of a Thousand Uses," and just how you may apply it to your product. The Bakelite Research Laboratories are at the disposal of manufacturers seeking cooperation in developing new applications of Bakelite.

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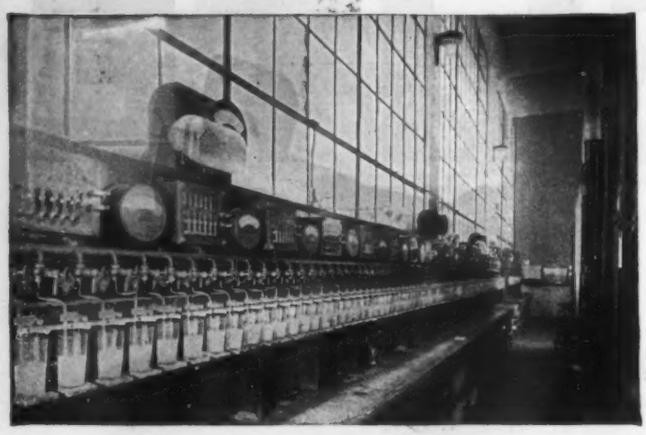
THE MATERIAL OF A THOUSAND USES



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Our chemists and metallurgists check up the composition of our alloys for the same reason that our mechanics gauge the work during the various stages of its manufacture.

The use of dependable, uniform raw materials makes it possible to obtain quantity production on a quality basis—at a profit.

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NOTES AND REVIEWS

Continued

propeller on an airplane is usually placed near other objects, and hence its performance may be modified by them. Results of tests on propellers free from slipstream obstructions both fore and aft are therefore subject to correction for the effect of such obstruction, and the purpose of the investigation is to determine the effect upon the thrust and the torque coefficients and the efficiency, for previously tested air propellers, of obstructions placed in the slipstream, inasmuch as the previous tests had been conducted under somewhat ideal conditions that are impracticable of realization in flight.

The plan of the study originally included the use of obstructions representative of the nose of the fuselage, of radiators or of other parts of an airplane structure, but a consideration of the wide variety of forms thus defined led to the selection of simple geometrical forms for the initial investigation. Such forms offered the advantage of easy exact reproduction at another time, or in other laboratories, and it was believed that the effects of obstructions usually encountered might be deduced or surmised from the effects of the ones chosen.

ALCOHOL-GASOLINE MIXTURES. By A. C. Zimmerman. Air Service Information Circular No. 450. Published by Chief of Air Service, City of Washington. 3 pp.

The purpose of the study is to investigate some of the properties of mixtures of aviation gasoline and 198-proof alcohol that has been denatured with 1 per cent of aviation gasoline. The material and the procedure are described and the results are discussed. The conclusions are stated as follows:

> The approximate percentage of the two constituents in the alcohol-aviation gasoline mixtures can be readily determined by the specific gravity or by adding an equal quantity of distilled water to the fuel.
>
> The presence of varying percentages of water caused immiscibility of the alcohol and gasoline. The amount of water necessary to bring about this separation increases slightly with the amount of alcohol present.
>
> Two per cent of water added to a 30-per cent alcohol-70-per cent gasoline mixture effects a practically complete separation at 70 deg. fahr. Three and one-half per cent of water is necessary in a 50-50 mixture at this temperature.
>
> Some idea as to the percentage of alcohol present can be gained by examination of the distillation curve of the mixture, since, as would be expected, an appreciable flattening of the curve results when alcohol is added.

AN INVESTIGATION OF THE MAXIMUM TEMPERATURES AND PRESSURES ATTAINABLE IN THE COMBUSTION OF GASEOUS AND LIQUID FUELS. By G. A. Goodenough and G. T. Felbeck. Published in Illinois Engineering Experiment Station Bulletin No. 139. 158 pp.; 27 illustrations; 36 tables.

The following excerpts from the introductory section of the bulletin will serve to show the problem proposed for investigation, the data required and the plan and the scope of the discussion.

> Certain chemical reactions that are associated with high temperatures possess great technical importance. Among these, especially interesting to the engineer, are the combustion reactions such as occur in boiler practice, in the internal-combustion engine, in the gas producer and in the oxy-hydrogen and the oxy-acetylene flame.
>
> Reactions at high temperatures present certain phenomena that have not received the attention they deserve from engineers. The reaction energy, that is, the available work of the reaction, is not generally the exact equivalent of the heat of reaction; however, this fact is not always recognized. Again, at high

(*Continued on p. 22*)

"AMERICA SHOULD PRODUCE ITS OWN RUBBER"—H. F. Firestone

The Public Has Spoken on Balloon Tires

The motoring public is demanding the comfort of low air pressure—from 25 pounds to a little over 30 pounds.

Regardless of individual opinion, we must accept these low pressures as the basis of what actually will occur when the car owners inflate their tires, whether oversize, semi-balloons or full-size balloons.

Nothing less than the genuine full-size Balloon cross-sections (4.40"—5.25"—6.20" and 7.30") will give full mileage at these low pressures.

About a year ago, after two million tire miles of test driving, Firestone approved and marketed the first full-size Balloon Gum-Dipped Cord.

Now a total of four million test miles have passed under the observation of our Development Department — more than 20 leading auto manufacturers have adopted full-size Balloons as standard or optional equipment—thousands of car owners in the field are changing their high pressure tires and wheels to full-size balloon equipment.

All this experience applauds and endorses without change the balloon tire cross sections and construction adopted by Firestone a year ago.

Our observations and computations cover tests of mileage, car control, road grip, gas consumption, power, acceleration, etc., and we believe are invaluable to automotive engineers who are using or considering using balloon tire equipment.

This data is at the disposal of automotive engineers who are interested.

Most Miles per Dollar

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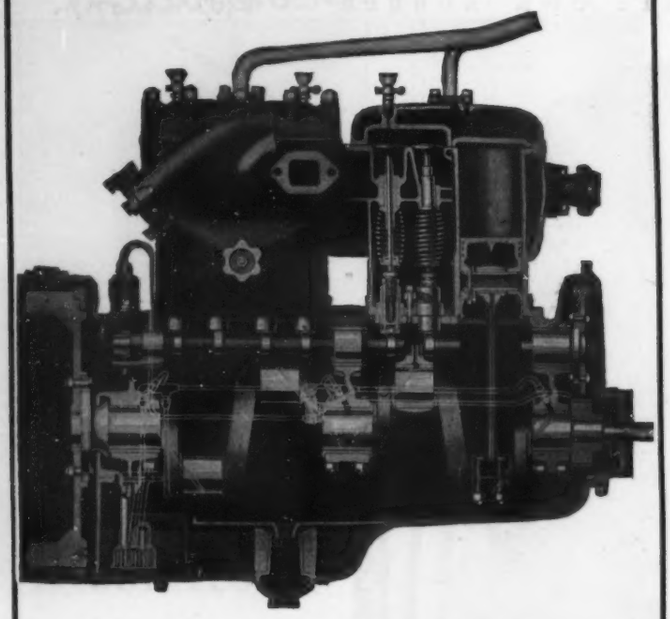

Trifles and Perfection

"Trifles Make Perfection But Perfection Is No Trifle." Nothing more true was ever penned. It is only by constant attention to trifles that perfection in engine building is approximated and this attention must be given at every stage of manufacture.

Hinkley Engines were designed well in advance of standard practice and when they were first introduced to the engine using world the universal construction of many builders was tight-head cylinders, splash feed lubrication, mushroom tappets, two bolt connecting rods, and other similar methods.

Hinkley Engines were in the lead then, and they have retained that lead today. They have consistently and steadily improved; not in design because the design was always fundamentally right; but in details. Every improvement has tended to make the engine more efficient, more economical, more powerful, and longer lived.

Our power curves show that we have succeeded in securing larger power output from identical cylinder bores than some of our contemporaries who lack the inclination, the information, or the trained personnel to give to details the attention which is necessary to secure maximum performance.

We have discovered that it is the ultimate user of Hinkley Engines whom we must please and all of the things we do to make Hinkley Engines better are dictated with the idea of making them easy to run, easy to service, and ready to perform their full duty at all times.

The dominant thought in this organization is that Hinkley Engines must be the best engines that Brains, Money, Machinery and Man can produce and to this end we have assembled a highly trained, intelligent, conscientious group of heavy duty engine specialists whose daily aim is the production of a finished engine worthy of bearing a Hinkley name-plate. They believe this label to be the blue ribbon of the engine world.

You are invited to avail yourselves of our facilities for producing your requirements in Heavy Duty Automotive Engines.

Model 300—3¾ x 5¼
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HEAVY DUTY AUTOMOTIVE
ENGINES

NOTES AND REVIEWS

Continued

temperatures a reaction cannot proceed to completion but must halt when the constituents attain a state of equilibrium. The maximum temperature that can be attained is thus definitely limited by the law of chemical equilibrium.

The problem proposed for investigation is, therefore, the following: first, to investigate the conditions of equilibrium and establish the necessary equilibrium equations; and, second, to incorporate these equilibrium equations into a formulation by which the maximum temperature resulting from the combustion of a fuel under predetermined conditions may be calculated.

The constants in the equilibrium equations involve certain thermal data, namely, the heat of combustion and the specific heats of the various constituents. The accuracy of the equilibrium equations depends, therefore, in the first instance, on the accuracy of these thermal data. The available experimental evidence on the specific heats of various constituents has been examined critically, and the discussion is given in Appendix I. In the same way the experimental evidence on heats of combustion is reviewed in Appendix II. One constant in the equilibrium equations is independent of thermal magnitudes, and its determination requires a chemical analysis of a gas mixture in the equilibrium state. In Appendix III, the chemical data for various reactions are assembled, and the unknown constants are determined for such reactions.

A brief resume of the important laws of gas mixtures is given in Chapter II. Then in Chapter III follows the general theory of chemical equilibrium and the derivation of the equilibrium equations for various reactions. In Chapter IV the energy equation is developed, and the method of solving the system of equations for the maximum temperature is shown. With this section the theoretical discussion is completed. The remaining sections are devoted to comparisons and applications of the theory.

STRENGTH OF MIXTURE HAS MARKED EFFECT ON ENGINE TEMPERATURE. By C. B. Dicksee. Published in *Automotive Industries*, March 6, 1924, p. 566.

Stating that there seems to be inadequate realization of the influence that mixture proportion has upon temperature, the author proposes to analyze the mixture upon which the engine usually operates and to illustrate by experimental figures how any change of mixture proportion influences the temperature of the engine.

The following factors that influence the temperature of the gases within the cylinder are discussed: (*a*) the quantity of heat liberated during combustion, (*b*) the weight of gases by which this heat is absorbed, (*c*) the specific heat of the products of combustion and (*d*) the heat lost to the cylinder-walls during combustion. The quantity of heat liberated during combustion is shown to be a function of the mixture-strength, as is also the weight of products by which the heat is absorbed. The specific heat of the products of combustion, although not capable of accurate determination, is known to increase with the temperature; and the quantity of heat lost during combustion, it is stated, will be some function of the temperatures reached while this process is going on. Detonation is discussed as a function of the rate of flame propagation.

Experiments are described and observations are tabulated to show the interdependence of combustion and engine temperature, and the author states that when any engine temperatures are quoted the mixture-strength must be given also, if a comparison is to be made. The practice of quoting mixture-strengths based upon the assumption of 100-per cent volumetric efficiency is condemned as being entirely misleading.

(*Continued on p.* 24)

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NOTES AND REVIEWS

Continued

FACTORS IN FUEL ECONOMY. Published in *The Autocar*, Jan. 4, 1924, p. 17.

This paper contains an account of an analytical investigation indicating the causes of good or bad mileage per gallon, illustrating the influence of certain carbureter and other adjustments, showing to some extent how the fuel consumption is affected by agencies outside the car itself, and, finally, demonstrating what a very great influence is exercised by the driver upon the distance that is obtainable from a given gasoline supply.

A brief summary of the requirements of maximum fuel economy includes the following: (*a*) avoid sudden accelerations, (*b*) maintain an even speed, (*c*) keep ignition advanced as far as possible, (*d*) avoid high engine revolutions on low gears, (*e*) "dead" weight has more effect on extravagance than has "live" weight and (*f*) imperfect contact-breaker points lead to fuel extravagance. The most economical speed was found to be 25 m.p.h. With reference to the effect of tire pressure it was stated that at 80 lb. pressure the maximum speed was slightly reduced, the fuel consumption was increased and there was complaint of discomfort over the bumps. A pressure of 40 lb. was found to be the most comfortable, and proved, at 20 m.p.h., to be the most economical. At the higher speeds 60 lb. pressure gave better fuel-consumption. The pressure was altered only in the rear tires, the front tires being kept at about 45 lb. each, in all the runs.

RESISTANCE OF VARIOUS ALUMINUM ALLOYS TO SALT-WATER CORROSION. By D. Basch and M. F. Sayre. Published in *Mechanical Engineering*, April, 1924, p. 199.

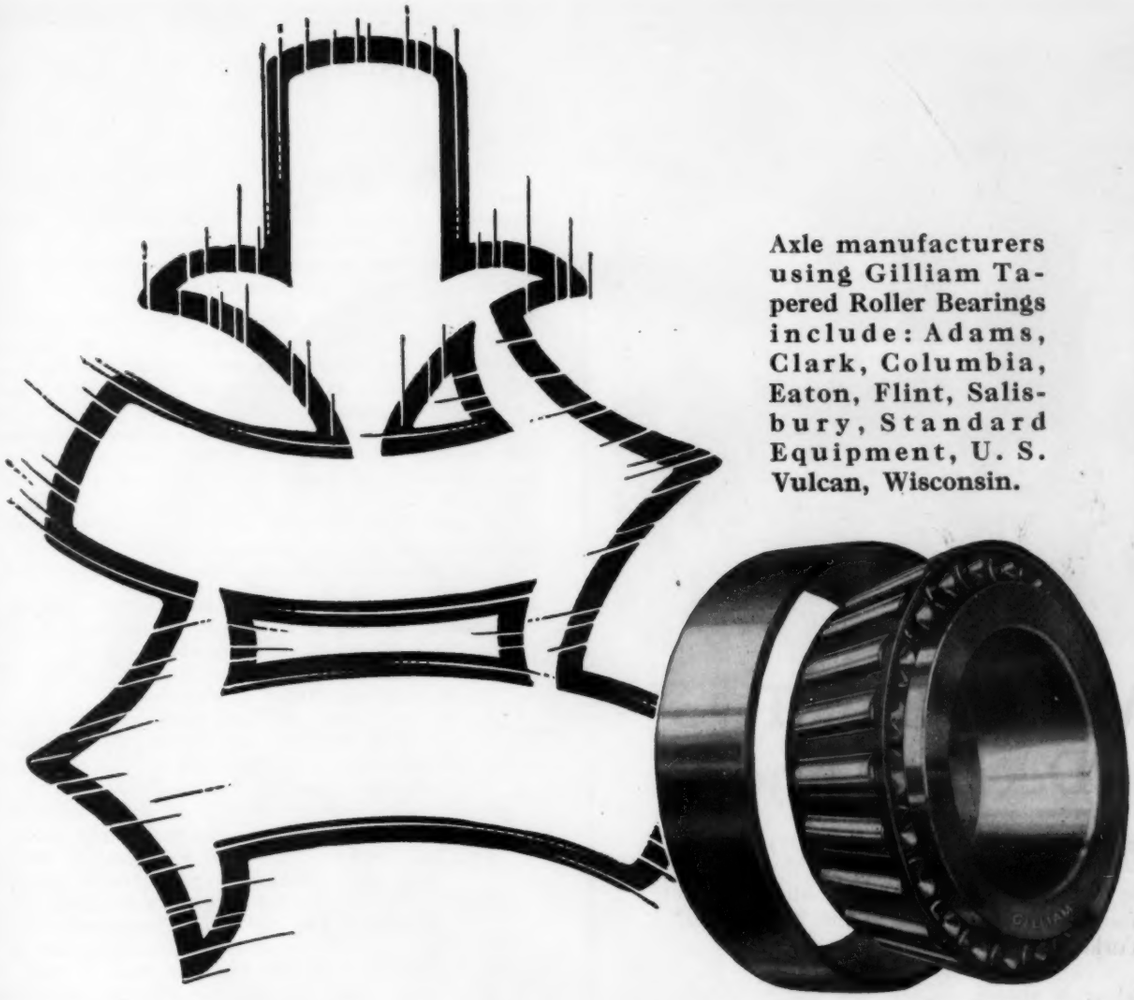
Believing that a handicap to the increased use of aluminum has been the lack of reliable information as to its resistance to deterioration in service, the authors conducted an investigation that took up first the general properties of the alloys and then the effect of corrosion under salt-spray conditions analogous to service on shipboard. This paper describes the apparatus used in the tests, the methods employed and the results obtained. It appears from the investigation that corrosion troubles hitherto experienced with aluminum alloys have been due to the use of unsuitable alloys and are not attributable to the inherent properties of the aluminum itself. Bases used in rating corrosion in the investigation are these four: appearance, gain in weight, depth of corrosion and per cent loss of strength. The study brought out the interesting fact that the range in rate of corrosion as between the different alloys is very wide, some alloys deteriorating more than 30 times as fast as others. The figures obtained from these tests contradict the idea that the corrosion resistance of aluminum alloys is in some way related to the tensile-strength; that is, that the high-tensile-strength alloys show a higher resistance to corrosion than those of low tensile-strength.

METALLURGICAL DATA ON STAINLESS STEELS. By H. H. Abram. Published in *Chemical and Metallurgical Engineering*, March 17, 1924, p. 430.

This paper gives the results of a careful investigation of the properties of stainless steels and tells how the properties most desired in any particular case may be obtained by heat-treatment. Tables show the chemical composition of stainless steels, the results of Brinell hardness tests after various rates of cooling and the results of mechanical and tensile tests of stainless steels in the oil-hardened and tempered condition.

Specimens of the steels in various heat-treated conditions were subjected to weather and to sea-water trials. General conclusions are formulated with reference to the anti-corrosive properties of specimens of different composition and condition. For example, under all circumstances the low-carbon steels had the greater resistance to corrosion, and the fully-hardened specimens resisted corrosion better than

(*Concluded on p. 26*)



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THIS "arrow form" mark is a symbol of a better Bearing performance in which the simultaneous forces of radial and thrust loads are better met.

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In the days of the Oldsmobile 21 years ago —Hayes began its career. At the time of the formation of the company all of Hayes product was furnished to the Olds Motor Works.

Below is shown one of the many Toggle Presses which are used in the production of Deep Drawn Stampings—such as Cowls, Seat Panels, Fenders, etc.

Hayes Manufacturing Co.

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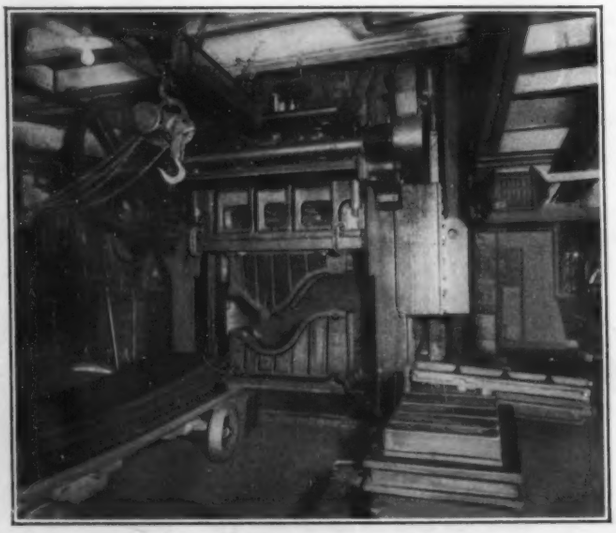

NOTES AND REVIEWS

Concluded

those in the tempered or annealed condition. Also, spraying with sea-water resulted in greater corrosion than did exposure to the weather; but whatever the condition of heat-treatment of surface finish, stainless steels were much superior in their anti-corrosive properties to ordinary carbon or low-percentage alloy steels.

RECENT OBSERVATIONS REGARDING THE CORROSION, CLEANSING AND PROTECTION OF ALUMINUM. By H. A. Gardner. Published in *Mechanical Engineering*, April, 1924, p. 206.

The opinion is expressed that regardless of the type of aluminum or aluminum alloy used, a protective coating is advisable to secure the greatest resistance to exposure around salt water. The qualities of various protective coatings are discussed. Cleansers for aluminum alloys receive consideration from the viewpoint of their possible corrosive effect upon the metal, and suggestions are given for making the cleansing process more efficient. Results of corrosion tests on aluminum and aluminum alloys are tabulated.

EDUCATION OF PEDESTRIANS NEEDED TO LOWER TRAFFIC HAZARDS. By A. B. C. Hardy. Published in *Automotive Industries*, March 27, 1924, p. 705.

In this article the following suggestions are offered as useful in reducing traffic difficulties:

(1) National coordination of traffic laws so that drivers will be governed by but one set of rules
(2) Designation for automobile use of certain streets that have no street-car traffic
(3) Discouraging the driving of automobiles on principal city thoroughfares that carry heavy street car traffic. This can be done by eliminating right and left-hand turns at each corner
(4) Detailing traffic policemen at all important intersections in the city and at important road crossings out of the cities on week-ends and holidays
(5) Enforcement of the old rule, both in and outside cities, that slow-moving vehicles must keep to to the right of the road

The author urges the need for education and plenty of it as the remedy for traffic accidents.

THE GRAPHICAL SOLUTION OF HELICAL GEAR PROBLEMS. By Franz Szabo. Published in *American Machinist*, March 13, 1924, p. 391.

A graphical method is outlined in this article whereby helical gear problems can be solved with a considerable saving in time, the results beng accurate enough to eliminate nearly all trial calculations. The purpose of the article, it is stated, is not to do away with the mathematical solution of helical gear problems nor to recommend any specific tooth helix angle for a set of given conditions, but merely to eliminate most of the preliminary tedious trial calculations where such are necessary and to reveal, or make at once known by diagrams, rules and conditions otherwise not easily seen beforehand. In using this graphical method, it is necessary to consider the tooth helix angles with respect to direction of rotation, and direction and magnitude of end-thrust of the gears, to see if they are practical, as is the case in the making of calculations. After outlining the method, the author says that, although it may at first seem complicated, once the principle is understood it is easy to see in one's mind most of the possible conditions shown by the diagrams, even without drawing them.

TOOTH BEARING CONTROL FOR SPIRAL BEVEL GEARS. By Charles H. Logue. Published in *American Machinist*, April 10, 1924, p. 549.

The importance of the position of the bearing along the length of the teeth is stressed. Pinion inclination is discussed as furnishing a definite means for measuring and controlling the proportional thickness of the teeth or of heel or toe bearing positions. The design and the operation of a gear-testing machine are described.

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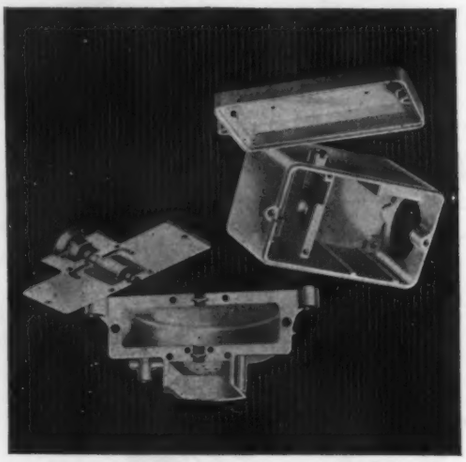

Persuasive or convincing salesmanship may secure an order for die-castings. But the purchaser does not become a customer in the true sense until he has proved the worth of that which he has bought.

Quality must back up salesmanship — if the "repeat orders" which are so desirable are to be expected.

When an order for Doehler Die-Castings is received, the continued efforts of the Doehler engineering, metallurgical and production organizations are concentrated upon delivering to the buyer castings of a quality which will make him a permanent customer.

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Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

Rodger Birdsell, who was formerly research engineer for the Bureau of Standards, City of Washington, has been appointed special equipment engineer for the Racine Radiator Co., Racine, Wis.

C. F. Blue, Jr., has been elected a director and vice-president of the Climax Molybdenum Co. of New York, and will make his headquarters in Pittsburgh. He was formerly president of the Carbon Steel Co., and also vice-president of the Pittsburgh Iron & Steel Foundry Co., both of Pittsburgh.

H. L. Brunger has severed his connection with the Vulcan Plow Co., Evansville, Ind., where he was works manager. His plans for the future have not been announced.

John M. Chappuis has accepted a position as mechanical draftsman for E. W. Bliss Co., Brooklyn, N. Y.

J. Coapman has become associated with the International Gear Co., Cleveland.

E. Y. Davidson, Jr., illuminating engineer for the Macbeth-Evans Glass Co., Pittsburgh, has been transferred to the Eastern division of the company at Charleroi, Pa.

A. M. Dean has become associated with the General Chemical Co., New York City. Prior to this he was engineer for the Swan Carburetor Co., Cleveland.

J. W. DeCou recently resigned as vice-president and general manager of the Fairfield Mfg. Co., Lafayette, Ind., to become associated with the Fageol Motors Co., Oakland, Cal.

A. L. Doerr, manager of the transportation division of the Star Motor Co. of California, Oakland, has resigned. No announcement has been made of his future plans.

Harry H. Gildner who was formerly in charge of the Chicago office of the Timken Roller Bearing Co., Canton, Ohio, has been made manager of the industrial division of the company, with headquarters at the main office.

Sidney G. Harris is now associated with the fleet department of the R. M. Hollingshead Co., Brooklyn, N. Y. Previously he attended the Polytechnic Institute of Brooklyn.

James S. Henry, who was until recently draftsman and tool designer for the Peerless Motor Car Co., Cleveland, is now connected with the engineering department of the Garford Motor Truck Co., Lima, Ohio.

Robert J. Hoffman, general manager of the Speedway plant of the Prest-O-Lite Co., Inc., Indianapolis, and the battery and small tank departments' sales and general oper-

(*Continued on p. 4*)

CLASS, STRENGTH AND DURABILITY, ROUNDNESS AND TRUENESS possessed in the SMITH EXPANDED AUTOMOBILE WHEEL, for balloon and standard sized tires are incomparable and non-competitive.

We are makers of approximately 70% of all metal truck wheels made and sold in America. Our new line of light, speed truck pneumatic wheels is also fast coming to the fore.

Smith Expanded Wheels help sell motor vehicles, whether passenger cars or trucks. They are the wheels of the future!

SMITH WHEEL, INC.

SYRACUSE, N. Y.

Exide
BATTERIES

Automotive engineers who know storage batteries, know about the dependability and long life of the Exide. They know, too, that it is *the* battery which combines maximum cranking ability with minimum size and weight.

THE ELECTRIC STORAGE BATTERY CO.
PHILADELPHIA

The world's largest manufacturers of storage batteries for every purpose.

In Canada, Exide Batteries of Canada, Limited
133-157 Dufferin Street
Toronto

PERSONAL NOTES OF THE MEMBERS

Continued

ations, has been elected vice-president of that organization. Since 1914 he has been associated with the Linde Air Products Co. and the Prest-O-Lite Co., both subsidiaries of the Union Carbide & Carbon Corporation, in various capacities.

J. C. Hooker is no longer service salesman for the Stratton-Bliss Co., New York City, but has joined the automobile department of the Fireman's Fund Insurance Co., San Francisco, and is located at its New York City office.

Prof. H. S. Hower, who was previously director of research for the Macbeth-Evans Glass Co., Pittsburgh, has become associated with the Carnegie Institute of Technology, Schenley Park, Pittsburgh.

E. F. Ingals, 2nd, has become associated with Carpenter & Gluck, Chicago.

F. E. H. Johnson has accepted a position as service-manager for the Noyes Buick Co., Boston.

J. T. Keller is no longer manufacturing executive for the Chevrolet Motor Co., Detroit, but has been appointed general manager of the General Motors of Canada, Ltd., Oshawa, Ont., Canada.

J. A. Kraus, who has been advisory and chief engineer of the Garford Motor Truck Co., Lima, Ohio, for the past 10 years, has resigned. No announcement has been made of his future plans.

Howard G. Leonard has been appointed district sales engineer for the Gall Auto Specialty Co., Denver, with headquarters in Albuquerque, N. M.

Fred Luker, who has formerly experimental engineer, in charge of the dynamometer room of the A. C. Spark Plug Co., Flint, Mich., has joined the engineering department of the Hupp Motor Car Corporation, Detroit.

George C. McMullen has been appointed district manager of sales on the Pacific coast for the Timken Roller Bearing Co., Canton, Ohio, with headquarters at San Francisco. He was until recently manager of sales of the industrial bearings division of that company and located at Canton.

R. D. MacMillen, who was previously director of sales and service for Albert Frank & Co., New York City, has become affiliated with Barton, Durstine & Osborn, also of New York City.

J. F. Merkel has been made mechanical engineer for the G. R. S. Products, Inc., Albany, N. Y. Until recently he held a similar position with the Cyclemotor Corporation, Rochester, N. Y.

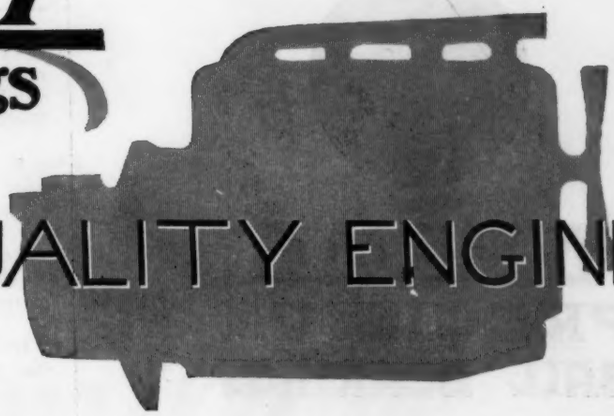
Fred C. Meyer is no longer stock clerk for the Uppercu Cadillac Corporation, New York City, but has accepted a position as salesman for the Nash Sales Corporation, Hackensack, N. J.

Julius H. Moritz has severed his connection with the Garford Motor Truck Co., Lima, Ohio, where he was draftsman. His plans for the future have not been announced.

Glenn Muffly is engaged in commercial research laboratory work on his own account at 508 South Dearborn Street, Chicago. Previous to this he was sales manager for the Lees-Bradner Co., Cleveland.

(*Concluded on p.* 6)

QUALITY Piston Rings for QUALITY ENGINES



THE performance of any engine will be no better than the performance of its piston rings.

Over one hundred leading manufacturers of quality engines recognize this fact by using **QUALITY** Piston Rings for initial installation. They know that every ring in every cylinder will function exactly the same as all of the others, and that the result will be a fine, smooth and efficient performance.

And for replacement, **QUALITY** Piston Rings are the logical choice as well. Accurately built to the proper oversizes, they can be installed in worn cylinders with the full assurance that they will hold compression, prevent oil leaking and render faithful, dependable service over a long and trouble-free period.

As a mark of identification and a guarantee of quality, each ring is stamped with the name "QUALITY". Oversize rings for replacement have, in addition, their oversize plainly marked on each ring.

The tradename **QUALITY** was selected as the only word suitable to fully express the actual values in each ring that bears this name.

The Piston Ring Company

Muskegon, Michigan

"NORMA"
PRECISION
BALL BEARINGS

For Lighting Generators
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Ignition Apparatus

What shall it profit a manufacturer if he save a few cents or a few dollars on the purchase of a cheap part, and lose a customer through poor performance?

Magnetos and lighting generators with "NORMA" Bearings continue—through years of changing standards—to be standard equipment on cars and trucks of the better class. Simply because—

Service records prove that magnetos and lighting generators with "NORMA" Precision Ball Bearings, run more quietly, last longer.

A booklet will be sent on request. And our engineers will welcome an opportunity to work with yours.

THE NORMA COMPANY OF AMERICA
Anable Avenue
Long Island City New York
BALL, ROLLER AND THRUST BEARINGS

PERSONAL NOTES OF THE MEMBERS

Concluded

C. C. Ostrom, who was formerly vice-president and sales manager of the Pennsylvania Forge Co., Bridesburg, Philadelphia, has entered into a partnership to be known as Esslinger & Ostrom, Philadelphia.

F. E. Queeney has been appointed New York district manager for the Commercial Truck Service Corporation, Philadelphia.

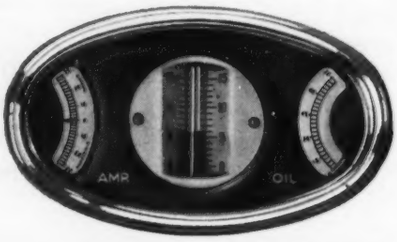
Robert H. Reid, who previously was associated with the Master Motor Corporation, Chicago, has been made general manager of Harold Bradley & Co., also of Chicago.

Irvin F. Richardson recently severed his connection with the Vacuum Oil Co., Boston, as automotive engineer, to accept a position with the Maxim Motor Co., Middleboro, Mass., as sales engineer.

Nicholas G. Rost has become secretary and general manager of Argus Association, Inc., New York City. He was previously affiliated with the Climax Engineering Corporation, Clinton, Iowa, as executive assistant.

C. R. Schuler, who for the past 9 years has been chief engineer of the Midwest Engine Co., Indianapolis, has been appointed sales engineer for the Hinkley Motors, Inc., Ecorse, Mich.

Walter C. Willard has become affiliated with the Vacuum Oil Co., and is working under the direction of the Western division manager in Detroit.



A NEW PANEL

Combining the Nagel Ammeter, Nagel Oil Gauge and a gasoline gauge of proved performance. Nagel standards are maintained in the neat and attractive panel as well as in the instruments.

NAGEL
AMMETERS · OIL PRESSURE GAUGES
PANELS · HOT MOULDED INSULATION
THE W.G. NAGEL ELECTRIC CO.
TOLEDO OHIO

Valve mileage

QUADRUPLED mileage with one-quarter the customary regrinds, is the story speedometers tell of the "indestructible" Thompson Silcrome valve.

Essential in achieving the product that sets a new "valve mileage" standard was, of course, the preliminary discovery of the alloy from which the first experimental valves were made. But of equal importance was the long, exhaustive process of adapting the original alloy to its best use as a vital engine part.

This manufacturing lore is the heritage of the originators of the Thompson Silcrome valve. It is also the safeguard of those who specify "Thompson Silcrome" for standard equipment. No valve, service and source considered, is so moderately priced.

THE STEEL PRODUCTS COMPANY

Also manufacturers of king, shackle and tie rod bolts, tappets, drag links, starting cranks, and brake rod assemblies

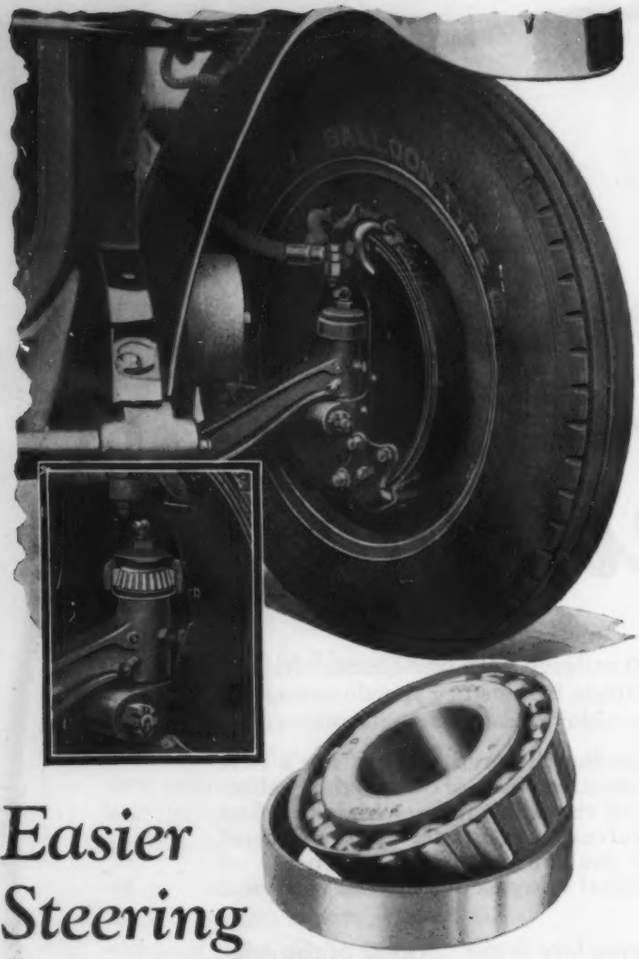
MAIN PLANT
CLEVELAND

MICHIGAN PLANT
DETROIT

—built by "a trail-breaker of industry"

THOMPSON SILCROME VALVES

SP



Easier Steering with Balloons

IN designing for balloon equipment, the steering problem becomes a paramount consideration. Some manufacturers are solving it with this specially designed Bock steering-pivot bearing.

The difficulties seemingly inherent in this application are done away with by the use of this multi-roller bearing of chrome nickel steel, the Bock D Type.

We guarantee easier steering. May we send samples for testing?

THE BOCK BEARING COMPANY, Toledo, Ohio

BOCK

***Quality* TAPER ROLLER BEARINGS**

Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

THE EFFECT OF WIND-TUNNEL TURBULENCE UPON THE FORCES MEASURED ON MODELS. By W. L. LePage and J. T. Nichols. National Advisory Committee for Aeronautics Technical Note No. 191. Published by National Advisory Committee for Aeronautics, City of Washington. 13 pp.

Tests are described that were undertaken to find the effect of turbulence in the air stream upon the lift and drag forces measured on models in the 4-ft. wind tunnel at the Massachusetts Institute of Technology. Maximum lifts and minimum drags were measured on Gottingen-387 and R.A.F.-15 airfoils, minimum drag on a streamlined strut and the static pressure gradients for different conditions of turbulence.

The results show that the scale of the turbulence, as defined in this report, has a marked effect upon the measured forces on models tested in the tunnel as well as on the pressure gradient, and it is recommended that further investigation of the phenomena be made with the aid of smoke and small wind vanes.

THE AERODYNAMIC FORCES ON AIRSHIP HULLS. By Max M. Munk. National Advisory Committee for Aeronautics Report No. 184. Published by National Advisory Committee for Aeronautics, City of Washington. 20 pp.

A new method is described for making computations in connection with the study of rigid airships, which was used in the investigation of the Navy's ZR-1. It presents the general theory of the air forces on airship hulls of the type mentioned, an attempt having been made to develop the results from the very fundamentals of mechanics.

The introductory part of the paper discusses the general properties of aerodynamic flows, comprising velocity potential, air pressure, kinetic energy and momentum. The main portion of the study is concerned with such topics as straight motion, circular path, distribution of the aerodynamic forces and a comparison with a model test. The concluding section contains remarks on the required size of the fins, the airship in circular flight and the aerodynamic forces on an airship flying through gusty air.

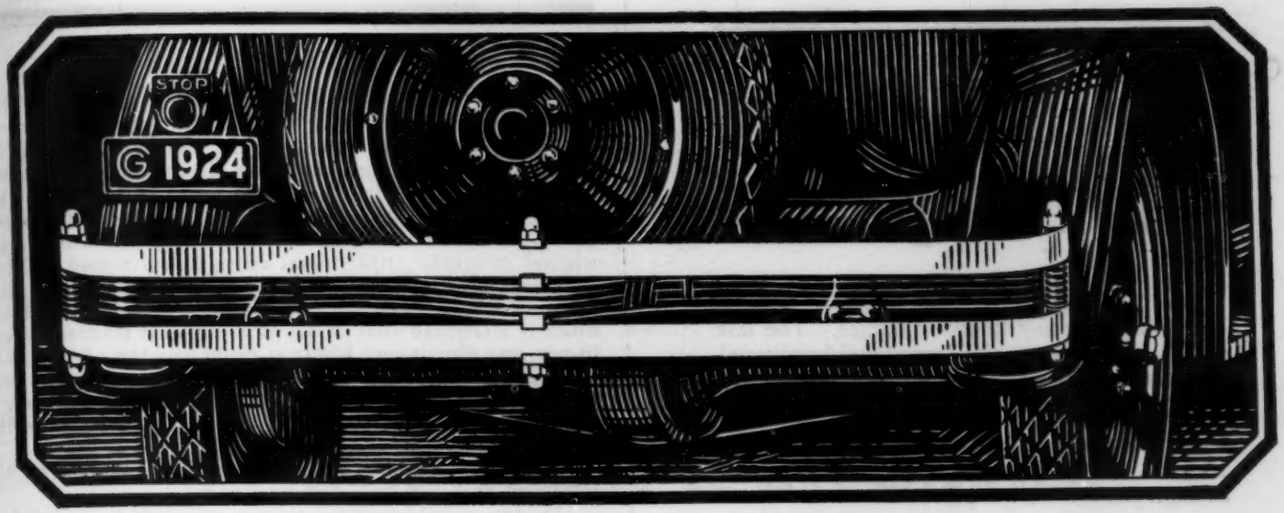
COMPARING THE PERFORMANCE OF GEOMETRICALLY SIMILAR AIRPLANES. By Max M. Munk and Edward P. Warner. National Advisory Committee for Aeronautics Technical Note No. 190. Published by National Advisory Committee for Aeronautics, City of Washington, 27 pp.

This paper deals with the model rules relating to aeronautical problems and shows how the characteristics of one airplane can be determined from those of another airplane of different weight or size and of similar type. If certain rules for the ratios of the dimensions, the weights and the horsepower are followed, a small low-powered airplane can be used for obtaining information as to performance, stability, controllability and maneuverability of a larger prototype and vice versa.

METALS USED IN AIRPLANE CONSTRUCTION. By F. O. Carroll. Published in *The Iron Age*, April 24, 1924, p. 1203. 6 illustrations.

After a brief outline of the present development of metals in the construction of aircraft, this article discusses the advantages and disadvantages of the various metals, with their characteristics and properties, their principal uses and examples of their application. First, steel and wood are compared as material for the construction of the main structural members of an airplane, and duralumin is next considered. The lightness and the strength of duralumin are discussed, as well as its property of increasing in strength and hardness with age and its resistance to corrosion. The point is made

(*Continued on p.* 10)



How Know a Good Bumper?

Efficiency in a bumper is told by maximum deflection and strength, with minimum weight.

C. G. Spring Bumpers are designed to utilize *all* of the steel in absorbing collision blows.

You do not carry superfluous weight when you equip with C. G. Bumpers. You only carry protection.

For Sale by Car and Accessory Dealers

WHAT IS A GOOD BUMPER?

A good bumper does not rust. Does not rattle. Is accurately attachable. Its fittings protect the frame. Bars are full width throughout their length. All of spring steel, oil tempered. Safeguards car and passengers by thoroughly cushioning collisions.

THE C. G. SPRING & BUMPER COMPANY
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C G *oil tempered*
BUMPERS

"It goes in the space"

Acme Wire "goes in the space," smoothly, easily, without any kinks or bulges. The last turn does not have to be forced and hammered into place.

It goes in the space because it is uniform, free from lumps, bare spots, and other imperfections. Its insulation is smooth, even, and of high dielectric strength.

Back of Acme Wire is a company that has pioneered in the development of fine silk- and cotton-covered enamel wire since the beginning of the magnet wire industry.

Back of it, too, are years of investigation and research in developing wire that exactly meets winding conditions. Acme knows these conditions thoroughly, for in our own plant hundreds of thousands of coils are wound each year.

The slightly higher cost of Acme Wire is returned many times over in the increased output of winders, the fewer rejected coils, and the longer life of windings.

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ACME WIRE PRODUCTS

"Enamelite," plain enameled Magnet Wire; "Cottonite," Cotton-covered Enamelite; "Silkenite," Silk-covered Enamelite; Single and Double Cotton Magnet Wire; Single and Double Silk Magnet Wire. We also have a complete organization for the winding of coils in large production quantities.

ACME VARNISHED INSULATIONS

Varnished Cambrics, Silks and Papers, Varnished Tapes in rolls; straight or bias. Varnished Tubing (Spaghetti).

ACME RADIO SPECIALTIES

Audio Transformer windings; Radio Frequency windings; Magnet windings for Head Sets; Enameled wire—especially the finest sizes, 40-44 B & S gauge; Silk and cotton-covered magnet wire; Enameled Aerial wire, single wire and stranded.

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NOTES AND REVIEWS

Continued

that duralumin is not suitable for structural members, as for example certain fittings, that take alternate repeated stress such as caused by vibration, since investigation shows that where the repetitions of stress have occurred 100,000,000 times, the tensile strength is reduced to about one-fourth the original strength. Other metal alloys that are used to fabricate certain parts and fittings are carbon-nickel-steel, chromium-vanadium steel, manganese bronze and electron metal, which is a German alloy of about 90 per cent magnesium and 10 per cent aluminum. Electron metal has the advantage of being only two-thirds as heavy as duralumin, but it is only about two-thirds as strong; it can be cast and in that state is very pliable, it being possible to double over the casting 180 deg. without cracking.

The author mentions the following disadvantages of all-metal airplanes:

(1) Any metal structure that is subjected to repeated alternate stresses will, in time, fail, and the main structural members of an airplane work under just this condition

(2) Unlike the wooden airplane, the all-metal machine will usually give no warning whatever of any incipient failure

(3) Unless the design of an all-metal airplane is calculated with extremely great care, it is liable to be much heavier than a similar wooden machine; further, the designer is considerably more limited by the practical working limits of the material rather than by the actual stresses in the members, particularly out near the tail and in the wings

INVESTIGATION OF THE Z-D PROCESS FOR TREATMENT OF LIGHT ALLOYS TO INHIBIT CORROSION, TO MINIMIZE POROSITY AND TO EFFECT DESIRED PHYSICAL PROPERTIES. By A. C. Zimmerman and Samuel Daniels. Air Service Information Circular No. 448. Published by Chief of Air Service, City of Washington. 22 pp.

The fact is stressed that the corrosion and porosity of light alloys have always been a source of concern in the functioning and the life of various parts of the airplane and more especially in connection with the fuel system. A process is described which consists successively in heating the metal, if a change in physical properties is desired; quenching in some medium; immersing in a warm aqueous solution of sodium silicate or water soluble silicates and, without washing, baking. It is claimed that the process prevents the corrosion of aluminum and its alloys more effectively and efficiently than any other inorganic coating process, that it is cheaply and easily applied, and that it causes but minor changes in the dimensions and the weight of the metal.

TORSIONAL STRENGTH OF NICKEL-STEEL AND DURALUMIN TUBING AS AFFECTED BY THE RATIO OF THE DIAMETER TO THE GAGE THICKNESS. By N. S. Otey. National Advisory Committee for Aeronautics Technical Note No. 189. Published by National Advisory Committee for Aeronautics, City of Washington. 21 pp.; 15 illustrations.

Since the ordinary torsion formula is based on elastic resistance to deformation, it is inaccurate for determination of ultimate stresses in thin-wall tubing subjected to torsional loads. It has been found that the torsional modulus of rupture varies with the ratio of the diameter to the gage thickness, and the object of this investigation is to determine the extent of these variations for nickel-steel and duralumin.

LIGHT ALLOYS FOR PISTONS AND CONNECTING-RODS. By Leslie Aitchison. Published in preprint form by The Institution of Automobile Engineers, London. 35 pp.; 33 tables.

In a brief introduction it is stated that light alloys as a material for automobile pistons possess, when compared with cast iron, certain advantages and certain disadvantages. Believing that the former outweigh the latter, the author thinks

(*Continued on p.* 12)

One of the most important automotive gatherings held annually is the S.A.E. Summer Meeting. Of course, the 1924 Meeting at Spring Lake in June will be reported authentically, timely and fully in the July issue of

The Journal of the Society of Automotive Engineers

ADVERTISING FORMS CLOSE JUNE 15TH

WORLD WIDE SERVICE

THE unfailing standard of quality that unceasingly characterizes Union Drawn Steel has placed its reputation high among users, large or small, throughout Europe and America.

No detail for the prompt and proper care of your needs is lacking. Enormous manufacturing facilities comprising three large mills are prepared to handle the heaviest demands. Every requirement in special analysis steel, in regular or special shapes, can be supplied. Large warehouses in five of America's greatest cities, together with widely distributed sales offices, are at your command.

These factors are a guarantee of punctual, dependable service, while precision in manufacturing and most careful inspection of every piece produced promise for you the same accuracy to detail that has stamped these products for 34 years.

UNION DRAWN STEEL COMPANY

BEAVER FALLS PA

NOTES AND REVIEWS

Continued

that some of the reasons for the neglect of these alloys by the automotive industry are due to comparatively incomplete information possessed by engineers regarding the materials that are available. The purpose of the paper is, therefore, to supply some relevant facts in regard to the variety of light alloys that are obtainable for use in automobile construction. The employment of light alloys for pistons is first discussed, followed by a consideration of their use for connecting-rods.

The discussion centers around an examination of various alloys with respect to the following attributes: (*a*) mechanical properties at ordinary temperatures, (*b*) mechanical properties at elevated temperatures, (*c*) machinability, (*d*) permanence, (*e*) ease of production in a sound state, (*f*) thermal conductivity, (*g*) thermal expansion and contraction, (*h*) cost, (*i*) specific gravity, (*j*) melting range, (*k*) facility of running in a cylinder and (*l*) hardness to resist wear.

The materials under consideration in this paper are the alloys of aluminum and magnesium. The general effect of the addition of copper is to raise the tensile-strength of aluminum, to reduce its ductility and to increase its specific gravity; the difference between the effect of equal proportions of copper and zinc does not appear to be great, except that the zinc-bearing alloys are rather more ductile. The silicon alloys are the lightest of all the binary alloys of aluminum so far quoted, a fact that in itself makes them of particular interest. An alloy of aluminum, known as "Y-alloy," contains copper, nickel and magnesium as its leading alloying elements, and is very similar to duralumin. It is probably the best alloy for pistons, but it requires heat-treating, and the expense of the operation is likely to be detrimental to its general adoption.

Light alloys possess superior thermal conductivity, but they compare unfavorably with cast iron with respect to the coefficient of thermal expansion, and this latter fact has a very marked effect upon the clearances to be allowed between the pistons and the cylinder walls. For purposes of comparison, a table gives properties of typical cast irons for pistons.

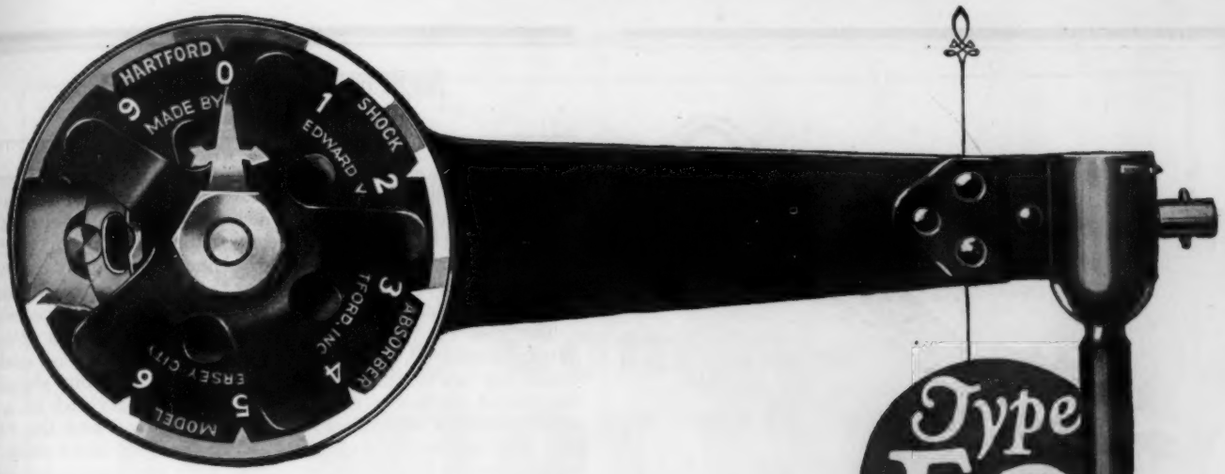
In connection with the subject of thermal expansion, attention is given to the idea that aluminum alloys "grow" considerably when they become heated in an engine. The author shows that the troubles that are thought to be due to "growth" are really due to warping, and he gives the remedy for this trouble. Between the rough and the final machining, the light-alloy piston should be heated to about 400 deg. cent. (752 deg. fahr); an exposure for 2 or 3 hr. is strongly to be recommended, and very slow cooling is not at all a necessary adjunct to success.

The temperature that limits definitely the working range of an alloy is that which causes the first melting of any part of the material; the melting of light alloys occurs at lower temperatures than does the melting of cast iron. In regard to casting, it is said that more troubles with light alloys are encountered through casting at too high a temperature than from any other cause. Shrinkage does not vary very greatly among the different light alloys except that the value for the silicon alloys is distinctly lower than for the remaining ones.

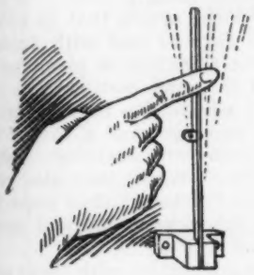
In summing up the data with reference to the use of light aloys for pistons, it is stated that, if the Y-alloy mentioned above is excepted, an alloy of aluminum with 8 per cent copper and an alloy of magnesium with 6 per cent of aluminum are the best. Where initial cost has to be taken largely into account, the former will doubtless be preferred; where weight is of supreme importance, the latter material has the advantage.

The light alloys that are suitable for connecting-rods are dealt with in the same way as those for pistons. Cast aluminum alloys are not particularly suitable for the manufacture of connecting-rods in which a reliably high strength and high ductility are required. The wrought light alloys

(*Continued on p.* 14)



The Touch of a Finger



The touch of a finger will stifle vibration on a string or spring.

It isn't necessary to clutch springs of a car with a frenzied pull as they start to expand. That method can only result in jerky spring action.

IN the TYPE F-C Hartfords there is a zone of free movement for the springs —free except for a *finger touch* of friction against the Hartford center arm. Thus when roads are smooth or with only minor inequalities the springs do the job practically alone, ***but without vibration.*** The finger touch stops that.

The resistance increases when roads get rough—but it is always gentle. It works ***both ways***—on compression and expansion—so it doesn't have to "grab". The riding result is surpassingly fine.

Sets for testing gladly furnished.

EDWARD V. HARTFORD, Inc.
JERSEY CITY, N. J.

Model 108-A, for
Cadillac, Lafayette, Lincoln, McFarlan, Marmon, Packard, Pierce-Arrow, Wills St. Claire

Model 107-A, for
Buick, Chalmers, Chandler, Chrysler, Cleveland, Dodge, Durant, Essex, Hudson, Hupmobile, Jewett, Jordan, Maxwell, Moon, Nash, Oakland, Oldsmobile, Paige, Reo, Rickenbacker, Rollin, Studebaker, Willys-Knight

Model 106-A, for
Chevrolet 4-90 and Superior, Gray, Overland, Star

Special Model for Ford Cars

Hartford
SHOCK ABSORBERS
"MAKE EVERY ROAD A BOULEVARD"

The Nation's Choice—

for Chief Magistrate is a matter of speculation, but its choice in the matter of automobile tool equipment has been unmistakably registered on the sales records of the Crescent Tool Company.

On first acquaintance the Crescent Wrench promises handy adaptability to a variety of emergencies, easy adjustment, firm grip, and effectiveness in the awkward narrow corners where most wrenches are helpless. On further acquaintance, it fulfills those promises with a faithfulness that many a political candidate could well emulate.

No car is completely equipped without a Crescent Wrench.

CRESCENT TOOL CO.

213 Harrison Street Jamestown, N. Y.

Originators and Manufacturers of

CRESCENT WRENCHES

NOTES AND REVIEWS

Continued

are better than the cast ones and compare very favorably with steel. The importance of testing a metal for its fatigue strength is emphasized, on account of the nature of the duties that the metal in a connecting-rod has to perform. The suitability of duralumin for connecting-rods is discussed, and the point is stressed that for the manufacture of connecting-rods in duralumin, drop-forgings are practically essential.

The risk of fire in the machining of magnesium alloys is briefly discussed, and the caution is given that in such an event the fire cannot be quenched with water but should be smothered with dry sand. Some space is devoted to a discussion of the white-metalling of the big end and the fitting of a bearing in the small end, in the case of light-alloy connecting-rods. The paper concludes with two pages devoted to the subject of forged light-alloy pistons. It is shown that such pistons are practicable, but the caution is given that changes of volume may possibly be experienced in service, if forethought has not been exercised.

ALUMINUM-SILICON ALLOYS. By J. B. Swan. Published in *The Automobile Engineer*, April, 1924, p. 102.

It is stated at the beginning of the article that in practice aluminum-silicon alloys are not easy to deal with from the foundry point of view, and some attention is given to precautions that must be observed if sound castings are to be produced. The most conspicuous advantages that the silicon-aluminum alloys offer over the more general alloys of commerce are said to be their elongation and ductility combined with a comparatively high tensile-strength; they also retain their strength and ductility while hot better than most light alloys, thus rendering wastage through porous and spongy castings less likely to occur.

A suggested line of research in connection with these alloys deals with the problem of increasing the hardness without affecting the ductility and other valuable properties.

Three tables show the mechanical properties of the aluminum-silicon alloys, mechanical tests of forged and rolled aluminum alloys and the effect on the Brinell hardness figure of increasing temperature.

In conclusion it is stated that (*a*) the aluminum-silicon alloys should be recommended with great caution, as the problem of melting and molding is not by any means within the scope of ordinary foundry practice and (*b*) except where great ductility is of extreme importance or the casting is of such a special nature as to require the use of an aluminum-silicon alloy, the more general alloys are at present to be preferred.

FERROUS ALLOYS RESISTANT TO CORROSION. By B. D. Saklatwalla. Published in *The Iron Age*, April 24, 1924, p. 1209. 6 illustrations.

Emphasizing the economic importance of the problem of corrosion in ferrous metallurgy, the author first traces the history of modern industrial attempts to produce, on a large commercial scale, steels resistant to atmospheric conditions, next describes tests that were conducted to show the corrosion-resisting properties of several steels and alloys in different conditions of heat-treatment and in different corroding media encountered in the industries, and then discusses briefly the future expansion of rustless metallurgy. Topics that receive consideration include (*a*) the effects of chromium in steel, (*b*) the comparative value of chromium steels with other engineering steels and (*c*) the effects produced in high-chromium steel by the addition of nickel, copper, manganese and silicon. It is stated that copper can be added to high-chromium steels to impart to them oxidation-resisting and acid-resisting properties, without certain drawbacks that are experienced from the addition of the other elements mentioned. The amount of copper necessary for this purpose is small, depending on the percentage of chromium, generally not exceeding 1.5 and in many cases not even 0.5 per cent. Such copper chromium steels, especially in the low-carbon

(*Continued on p.* 16)

Dole

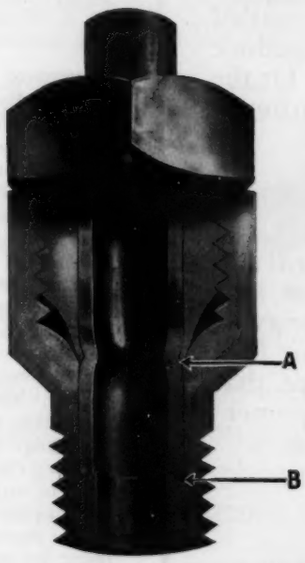
Double Compression COUPLINGS for Oil and Gasoline Lines

"The Perfect Nonleakable-Re-connectable Joint"

Note the Double Joint

A—where the screw compresses the tube.

B—where the tube is swedged into the "V" slot.



Absolutely insures against vibration and leakage. This fitting requires no soldering, no brazing, no flaring of the tubes and no sleeves.

Following are some of the users of Dole Double Compression Couplings:

Automobile

Buick Motor Co.
Checker Cab Mfg. Co.
Cleveland Automobile Co.
Elcar Motor Company
Falls Motor Corp.
H. H. Franklin Mfg. Co.
H. C. S. Motor Car Co.
Kissel Motor Car Co.
McFarlan Motor Co.
Maxwell Motor Co.
Oakland Motor Car Co.
Pilot Motor Car Co.
R. & V. Motor Co.
Rollin Motors Co.
Rickenbacker Motor Co.
Stutz Motor Car Co.
Stephens Motor Car Co.
Willys Overland Co.

Truck, Tractor, etc.

Ahrens Fox Fire Engine Co.
Available Truck Company
Advance Rumley Co.
Associated Manufacturers Co.
American-LaFrance Fire Engine Co.
C. L. Best Tractor Co.
Buffalo Truck & Tractor Co.
Stewart-Warner Speedometer Corp.
Cleveland Tractor Company
Cushman Motor Works
Garford Motor Truck Co.
Gas Engine Div. Hercules Corp.
Hal-Fur Motor Truck Co.
International Harvester Co.
Ideal Engine Company
Fageol Motors Company
Nelson Brothers Co.
Rock Island Plow Co.
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Waukesha Motor Co.
Weber Engine Co.
Waterloo Gasoline Engine Co.

The Dole Valve Co., 1923 Carroll Ave., Chicago, Ill.

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The Most Nearly Frictionless Type of Bearing Is Naturally The Most Efficient

Friction wastes energy, causes wear, destructive vibration and loss of alignment. As these factors develop, operating efficiency is correspondingly decreased; and deterioration of shafts and gears, as well as of the bearings themselves, is rapidly accelerated, with premature failure as the ultimate goal.

Therefore the problem of the so-called anti-friction bearing is clearly to reduce friction. As the *ball* bearing is by far the most nearly frictionless, it is manifestly the logical type to use.

Fafnir Ball Bearings are scientifically manufactured from thoroughly heat treated chrome alloy steel. In order to insure continued efficient operation it is only necessary to select the proper type, size and method of mounting *Fafnir Ball Bearings,* and to this end we hope that you will permit our engineers to cooperate with those of your organization.

All standard types and sizes.

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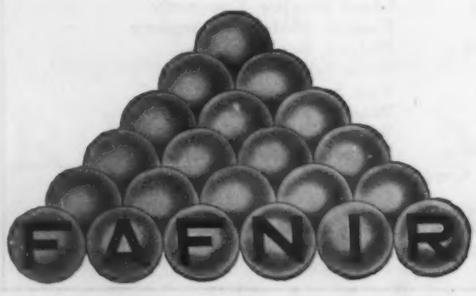
CLEVELAND, OHIO.—1016-1017 Swetland Bldg.
NEW YORK, N. Y. 5 Columbus Circle.
NEWARK, N. J. 271 Central Ave.
PHILADELPHIA, PA. 1427 Fairmount Ave.



NOTES AND REVIEWS

Continued

ranges, present very remarkable non-corrosive properties. The acid-resistance is obtained not only without sacrificing any of the oxidation-resisting properties, but the copper actually helps the chromium to withstand oxidation better. Also the copper-chromium steels are not so much dependent on the state of hardening to bring about non-rusting and non-corrosive properties as the plain high-chromium steels. On account of the small amount necessary and the low price of copper, such steels seem to have a very promising broad industrial future.

In conclusion the author expresses his belief that the future of commercial development and of wide engineering application undoubtedly lies with the low-carbon alloys, either containing chromium alone or together with another element such as copper.

CHROMIUM-PLATING STEEL. By Kevie W. Schwartz. Published in *Chemical and Metallurgical Engineering*, April 21, 1924, p. 627.

The author gives the detailed information necessary for the production of a successful chromium plate. The points considered include the following: (*a*) the effect of chromium sulphate concentration at various current densities, (*b*) the effect of hydrogen ion concentration, (*c*) the effect on the deposit of substituting chromium anodes in place of lead and of platinum anodes and (*d*) the extent of the passivity of the chromium anodes after prolonged electrolysis.

PRECISION MEASURING INSTRUMENTS USED IN GAGE INSPECTION. By George K. Burgess. Published in *Army Ordnance*, May-June, 1924, p. 375. 8 illustrations.

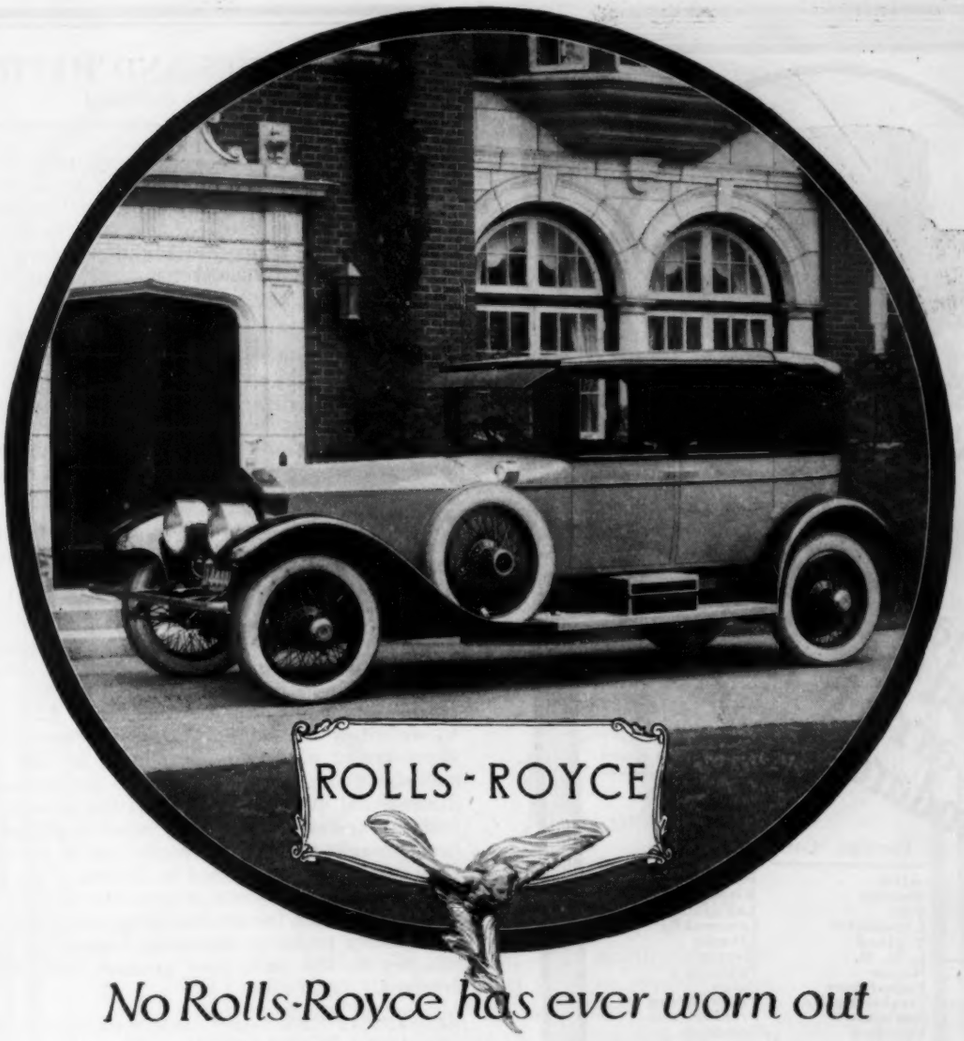
Instruments are described which are employed at the Bureau of Standards for determining accurately a dimension either by direct measurement or by comparison with a standard. Such instruments include a measuring machine for determining standards of length; precision gage-blocks that when used in sets can determine dimensions to within 0.0001 in.; test indicators that prove useful in quantity production in the inspection of parts on which very small tolerances are permitted; dial micrometers that may be used in cases where moderate tolerances are allowed; optical projection apparatus for measuring screw-thread gages, taps, screws and similar pieces; lead-measuring machines used in measuring pitch diameter; and an interferometer for determining the length of a gage by light waves.

The principle of the interferometer is very interesting. A wave of any given color, such as those emitted by incandescent pure cadmium, helium, or neon, is constant in length, accurately reproducible, and may be readily applied in measurement by methods that make use of interference of light waves. The length of a precision gage-block, selected for its accuracy as to planeness and parallelism of its surfaces, may be determined by using it as a separator for two interferometer plates, thus forming what is known as a Fabry and Perot interferometer.

The interferometer formed by a gage and two plates is placed within a constant-temperature chamber in front of the slit of a grating or prism spectograph. Light from a neon lamp is focused by a lens upon the two plates of the interferometer. Part of the light is transmitted directly through the interferometer, part is reflected by the platinized surface of one plate to the platinized surface of the other plate, where it is again partially reflected, and then a part of it passes on through the first plate, and so on through a large number of multiple reflections and transmissions. The reflected and directly transmitted parts when combined produce a system of interference rings which is focused by a second lens upon the slit of the spectograph. The images of the slit corresponding to the different radiations from neon are separated by a grating and recorded on a photographic plate.

By measuring the diameters of the interference rings thus photographed, knowing the nominal length of the gage, it is possible to calculate the exact number of light waves, and

(*Continued on p.* 18)



No Rolls-Royce has ever worn out

The Rolls-Royce has won world-wide distinction in the aristocracy of motordom through its high quality, quiet dignity, grace, and a power plant that approaches the ultimate in reliability and lifetime ability to serve.

To guard zealously this reputation, Rolls-Royce engineers are naturally critical in their choice of auxiliary units. They have selected Westinghouse Starting and Lighting Apparatus as standard equipment.

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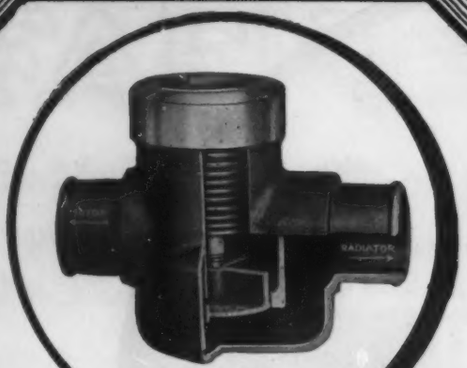
Sales and Service Headquarters: 82 Worthington St., Springfield, Mass.

Westinghouse



Cut Open View

28 makes of cars and 3 trucks carry it as Standard Equipment!

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Duesenberg
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Foreign Cars
Alvis
Bentley
Fiat
Lanchester
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L. G. O.
Napier
Rolls-Royce
Straker-Squire
Sunbeam
Vauxhall

Trucks
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Sylphon Automobile Temperature Regulator

Sylphon Automobile Temperature Regulator consists of three main parts: The Sylphon—that seamless, flexible, all-metal expansion member, which is the heart of all Sylphon products; a valve and a housing for the Sylphon. The Sylphon is filled with a highly volatile liquid, which vaporizes at a predetermined temperature, expanding the Sylphon and opening the valve to admit water, and contracting and closing the valve when the temperature falls. Is self-regulating, adapted to pump or thermo-syphon cooling systems, can be installed between the radiator and the engine, either in outlet or inlet water connection. Has no moving parts to wear out, needs no oiling and will outlast the motor. Do not accept imitations or substitutes.

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NOTES AND REVIEWS

Continued

fraction of a wave, between the plates. After applying various small corrections, depending upon the density and the humidity of the air, the lack of exact parallelism of the gage surfaces, the thickness of the metallic film on the interferometer plates, temperature and pressure, the length of the gage block at standard temperature is obtained to within 0.000001 in.

MODERN PRECISION MEASURING INSTRUMENTS. By W. L. Whitmarsh. Published in *Army Ordnance*, May-June, 1924, p. 381.

This article describes the standard types, the functioning and the use of such instruments as micrometer calipers, vernier tools, limit gages, amplifying dial-gages, amplifying fluid-gages, checking gages, precision gage-blocks, optical flats and the interferometer.

THE CONTROL OF QUALITY IN MANUFACTURING. By George S. Radford. Published by the Ronald Press Co., New York City. 404 pp.; 89 illustrations.

After attention has been called to the close association of quality with usefulness and marketable possibilities, the introductory chapters of the book discuss the general relationships of quality to manufacturing. On account of the part played by inspection in controlling quality, the various forms of inspection are studied. The latter half of the book takes up definitely the relation of measurement to quality and the development of quality standards in the various types of manufacturing. In this connection the methods for controlling dimensional quality are used as the principal example; it is realized, however, that many other qualities have not as yet been brought to the same perfection of control as has dimension, and color is discussed as typical of these other qualities. The concluding chapters present the author's idea of the best method of attack for approaching and bringing under control any quality problem whatever, regardless of the particular industry or the particular product that may happen to be involved.

MECHANICAL ENGINEERS' HANDBOOK, Lionel S. Marks, editor-in-chief. Published by the McGraw-Hill Book Co., Inc., New York City. 1986 pp.; illustrated.

This, the second, edition is, according to the preface, an attempt to state the best engineering theory and practice as it stands at the beginning of 1924 in those branches that are of most interest to the mechanical engineer. The subjects that have undergone most change in this edition are hydraulics, heat, iron and steel, non-ferrous metals and alloys, bearings, steam boilers, internal-combustion engines, aeronautics and air compressors, but all sections have been thoroughly revised. Among the more important of the new topics are drying and lubrication.

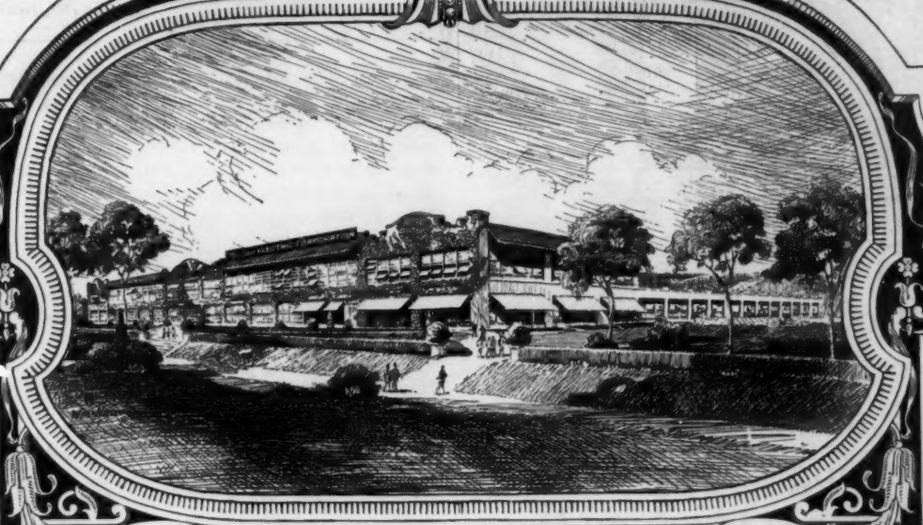
AUTOMOBILE REPAIRING. By Ben G. Elliott. Published by the McGraw-Hill Book Co., Inc., New York City. 431 pp.; 375 illustrations.

This book, intended primarily for instructional and reference purposes, presents the fundamental principles employed in the various repair operations on the modern gasoline automobile and its equipment. It is of interest to automobile repairmen, students, car-owners and others who desire a good working knowledge of the principles of automobile care and repair.

DIE SCHMIEROLE FUR AUTOMOBILMOTOREN. (Lubricating Oils for Automobile Engines.) By H. Franz. Published in *Der Motorwagen*, March 10, 1924, p. 105.

This paper deals with the general theoretical principles underlying the lubrication of automobile engines and the properties of lubricating oils best suited for this purpose. Topics that receive consideration include the viscous flow between plane surfaces and in capillary tubes, the flash-point and specific gravity of oil and the relation between viscosity

(*Continued on p.* 20)



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Starting, Lighting and Ignition System

The last word in plant and equipment, in addition to the finest design and highest grade of materials, was necessary in order to give a select few builders of fine motor cars an electrical system beyond any previous standard of excellence. Evidence of the quality effort behind DeJon is found even in the atmosphere where DeJon is built: in the modernized factory with its ivy-grown walls and park-like surroundings. Ample proof of DeJon's superiority is found in the way it endows a fine car with an unprecedented degree of efficiency

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STORAGE BATTERIES

A nationally known product of uniform excellence—exclusive equipment on cars of recognized class—meeting every requirement for starting and lighting—built to a high standard of quality by a pioneer in the industry—backed by liberal guarantees that mean what they say and by user-satisfying service everywhere—accepted today without question by the new car buyer—a product whose amazing increase in popularity during the past three years among manufacturers, dealers and users has been an outstanding feature in the battery business.

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NOTES AND REVIEWS

Continued

and temperature. Specifications for lubricating oils suitable for automobile cylinders are given as follows: Pure mineral oil free from mechanical contamination and from acid; specific gravity, 0.900 to 0.930; viscosity at 50 deg. cent. (122 deg. fahr.), 9 to 12 deg. Engler in summer and 7 to 10 deg. Engler in winter; flash point, over 180 deg. cent. (356 deg. fahr.); ash content not more than 0.02 per cent. The addition of graphite to lubricating oil is condemned.

OIL INDUSTRY LIKELY TO TAKE LEAD ON ANTI-KNOCK FUEL. By Paul Truesdell. Published in *National Petroleum News*, May 7, 1924, p. 25.

The advantages of engines with higher compression are discussed, and it is stated that as long as the present gasoline, with the paraffin series of hydrocarbons predominating, continues to be the only generally available fuel, possible compression-pressures have already reached their limit. After mentioning the work done by General Motors Research Corporation with the idea of finding a chemical that could be added to gasoline to neutralize or remove the objectionable characteristics that cause detonation, the article tells about the work of an oil chemist who claims to be able to produce a motor fuel that lacks the objectionable characteristics. This fuel is a gasoline in which the naphthene series of hydrocarbons predominates, and in which members of the paraffin series are almost altogether eliminated. It is claimed that the new anti-knock motor fuel will be equally effective with ethyl gas and cheaper to manufacture and market. The inventor disagrees with the idea that, by the use of improved fuels, approximately twice as much power can be generated per pound of engine by the same quantity of gasoline as is developed by present designs; he asserts that an increase in efficiency of about 15 per cent is all that can be expected.

THE SOLID-INJECTION OIL ENGINE. By H. F. Shepherd. Published in *Mechanical Engineering*, May, 1924, p. 251. 28 illustrations.

The author has undertaken to present the most pertinent facts on the development of the solid-injection oil engine from the former hot-surface unit. The paper points out the influence of combustion-chamber design, spray angle and velocity, atomization, detonation, turbulence and other problems confronting the oil-engine designer.

THE SHELL GASOLINE PUMP. Published in *Engineering*, March 7, 1924, p. 301. 10 illustrations.

A curbside pump is described that was designed in an effort to provide means whereby the purchaser of gasoline supplied through one of these pumps can satisfy himself that he is obtaining full measure and that the quality of the gasoline is that for which he pays. The gasoline is placed in an underground tank, a certificate as to its quality being supplied with each delivery and fixed in a prominent position on the pump.

The gasoline is raised from the underground tank by a hand-operated semi-rotary pump and delivered into one of two measuring-vessels or containers, through a four-way plug-cock. When one of the containers is filled, the fact is indicated by the overflow of gasoline through a sight-glass, and the plug-cock is reversed so that the other container receives gasoline while the filled container discharges its contents into the tank of the customer's car. In addition to the overflow sight-glasses, another sight-glass is located at the bottom of each container, to give evidence that the delivering container is completely empty before it receives another supply of gasoline. An indicator shows the total amount of gasoline taken from the tank and the amount supplied to each customer. In addition to the evidence furnished by the sight-glasses and the indicator, a bell rings each time the handle of the plug-cock is turned, thus giving an audible notification of the quantity delivered.

The pumps are made in two sizes that deliver the gasoline

(*Continued on p. 22*)

7500 New Cars

were finished in DUCO during the month of April!

Tens of thousands of DUCO finished cars already on the road

AUTOMOBILE manufacturers have been quick to see the added sales advantage of cars finished in DUCO — the new finish that is impervious to weather conditions.

In addition to the Oakland Motor Car Co., who have standardized on DUCO finish for all their 1924 cars, the manufacturers of Cadillac, Cleveland Six, Franklin, Lexington, Marmon and Moon have arranged to finish their cars in DUCO on request. A dozen other manufacturers are arranging to do so.

A great popular demand for DUCO has arisen not only in response to our advertising in The Saturday Evening Post, but also largely through word-of-mouth advertising — the real indication of DUCO'S worth and, at the same time, the most desirable and effective kind of publicity. It is today one of the most talked-of developments in the automotive industry.

DUCO, in addition to its many advantages to the car owner, means production economy for the manufacturer. Due to its quick-drying qualities, DUCO is materially reducing finishing time. This represents an enormous saving in storage space, and investment in finished product.

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FOR twenty-one years, Spicer Universals have shared responsibilities for the performance of America's leading motor cars. The whole life of the industry!

Twenty-one years of opportunity for car manufacturers to test and compare. Yet they have never found a better universal for such carefully designed jobs as

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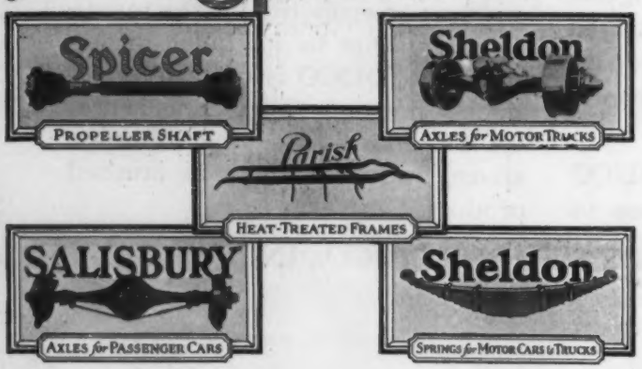

Spicer Manufacturing Corporation, South Plainfield, N. J.
Parish Manufacturing Corporation, Reading, Pa.
Sheldon Axle & Spring Company, Wilkes-Barre, Pa.
Salisbury Axle Company, Jamestown, N. Y.

Q120-4

NOTES AND REVIEWS

Continued

in units of ½ and 1 gal. respectively. By the alternate filling and emptying of the two containers, the delivery of gasoline to a car is practically continuous, and the ½-gal. size can supply gasoline at the rate of 10 gal. per min.

VARIABLE TRANSMISSION. By G. Constantinesco. Published in *The Automobile Engineer*, March, 1924, p. 76.

In Part V of the series of articles relative to his transmission device, Mr. Constantinesco analyzes the behavior of his torque converter with regard to a condition that is stated as follows: The vehicle shall be manageable either by maintaining the torque of the engine at any desired value and for any desired time, from zero up to the maximum torque, or by maintaining the speed of the engine for any desired time at values between the minimum and the maximum for which it is designed.

In conclusion the author states that it was his intention in this series of articles to present a critical consideration of the problem solely from the theoretical standpoint and that he hopes to deal at a later date with the questions of efficiency, reliability and other practical points, when details of the construction and the test results of full-sized converters will be included.

ADEQUATE AND ECONOMICAL ILLUMINATION OF BUSES. By A. C. Roy. Published in *Motor Vehicle Monthly*, May, 1924, p. 28. 5 illustrations.

Lighting requirements of buses are analyzed from the viewpoint of the operating company and of the public, and are summarized in the statement that a well lighted motor-bus should include the following:

(1) Glass reflectors instead of enclosing domes
(2) Twenty-one candlepower Mazda lamps in ceiling fixtures
(3) Twelve-volt system
(4) No. 8 stranded wire, battery to switches
(5) No. 12 stranded wire, from switches to lamps
(6) All joints soldered
(7) Toggle or knife switches of ample size
(8) Twenty-one candlepower lamp in steplight fixture
(9) Storage-battery to carry lighting load for from 6 to 8 hr.
(10) Generator of sufficient capacity to provide current for the lighting load and keep the battery charged
(11) Ceiling painted gloss white with medium-colored side walls

RELATION OF CHASSIS TO BUS-BODY CONSTRUCTION. By Charles A. Heergeist. Published in *Motor Vehicle Monthly*, May, 1924, p. 19. 9 illustrations.

In this article five different types of bus are illustrated and described, and the various requirements of the chassis for each type are shown. An interesting feature of the article consists of a scale drawing of each of the five types of bus under consideration.

ULTRA-VIOLET RAYS USED TO TEST BODY FABRICS AND FINISHES. By W. L. Carver. Published in *Automotive Industries*, May 8, 1924, p. 1011. 5 illustrations.

Apparatus and experiments are described that have as their purpose the testing of the color characteristics and the durability of upholstery fabrics, top materials and body finishes. It is stated that the time element, which has been the chief disadvantage of outdoor exposure tests of these body materials, is being reduced to a period comparable to an engine break-down test by the utilization of the quartz-tube mercury vapor lamp that emits ultra-violet rays.

IMPORTANT HARDWOOD CONSERVATION BY FORD. Published in *Autobody*, May, 1924, p. 190. 6 illustrations.

Methods are described that are said to permit savings of from 35 to 50 per cent in the cutting of hardwood for automobile-body parts, the added advantage being claimed that the body parts produced are superior to those sawed out of edged-and-trimmed boards.

(*Continued on p.* 24)

Acceptance

The Firestone program of a few sizes to fit every make of car, fills every requirement of the trade and the motoring public. It simplifies manufacturing and selling.

More than twenty-five leading car manufacturers and more than 50,000 car owners endorse Firestone Full-Size Balloon Gum-Dipped Cords by placing them on their cars.

Firestone has complete data covering all phases of balloon operation, including mileage, car control, traction, fuel consumption, power, acceleration, etc.

This material is based on closely supervised tests of upwards of four million miles and is offered for reference to automotive engineers who are interested.

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CORDS

The Original Low Pressure Tire

AMERICA SHOULD PRODUCE ITS OWN RUBBER ... H. S. Firestone

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DEOXIDINE

Rust Remover—Acid Neutralizer

Rule-of-Thumb methods are rapidly passing out of the industrial picture. Production and other problems are successfully solved only through careful planning and by the application of sound scientific principles.

That the Automotive Industry has realized this fact in the preparation of metal surfaces for painting, is evidenced by the adoption of A.C.P. Products by the industry almost as a whole.

DEOXIDINE, one of the A.C.P. Products, affords an easy and inexpensive method of preparing metal surfaces for permanent paint jobs. It absolutely removes and prevents all rust and neutralizes the rust stimulators.

The old methods of cleaning surfaces—gasoline, benzine or some other oil solvent—only hit the high spots, even though it was followed by a scrubbing with emery cloth, sandpaper or steel wool or perhaps a sand blasting. In the minute depressions of the metal, rust germs were still present and started to undermine the paint job in a short time.

DEOXIDINE prevents rust working under the paint, by destroying entirely the rust germs. **It is a guarantee of paint job permanence.**

We have made the study of the preparation of metal surfaces for permanent paint jobs a life study. This experience is available to every executive and engineer. We can advise you about the prevention of such and all other paint failures. Just drop a line to us for complete details. There's no obligation on your part.

American Chemical Paint Co.

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AMBLER, PENNA.

Protect the Paint That Protects Your Product

NOTES AND REVIEWS

Continued

PRODUCTION METHODS IN CENTRAL EUROPE. Published in *The Automobile Engineer*, April, 1924, p. 106. 21 illustrations.

This paper tells of a visit that was made to certain automobile works for the purpose of obtaining a first-hand impression of the production methods and equipment of the larger factories in Germany and the adjacent countries. Topics covered include mass-production methods, machine-tool equipment, inspection and testing apparatus, utilization of waste material and the training of apprentices.

THE IMPRESSIVE STORY OF FIAT. By J. A. Lucas and F. E. Bardrof. Published in *American Machinist*, April 24, p. 603; May 1, p. 655; and May 8, 1924, p. 693. 31 illustrations.

The first article of the series describes the plants and their products. The second and third articles are concerned with the manufacture of ball bearings.

The Fabbrica Italiana Automobili Torino is one of the largest automobile plants in the world. The industrial, mechanical and metallurgical establishments of the company embrace more than 20 large plants, having approximately 420 acres of floor space and furnishing employment for more than 26,000 persons. It is developing its production scheme to handle a great many of its products from the procurement of the raw material to the finished machines. The influences of American methods and tools may be seen, but it is clear that there is intelligent adaptation and not blind following. Their products include motor trucks, motorbuses, passenger cars, airplanes and airplane engines, motorboat engines, marine Diesel engines up to 6000 hp., caterpillar tractors and tanks, four-wheel tractors for agricultural and other uses, stationary and portable oil engines and ships up to 11,200 tons in size.

The first of the two articles on the production of Fiat ball bearings describes the machining operations on races for radial and thrust bearings together with the hardening, grinding and polishing of races, and the second of these two articles tells about the forging, hardening and grinding operations on the balls and the machining of the separators and the assembly of the bearings.

RAIL-CAR DESIGN PROBLEMS PRESENTED TO AUTOMOTIVE ENGINEERS. By P. M. Heldt. Published in *Automotive Industries*, April 24, 1924, p. 918.

Predicting that the next few years will see the introduction of gasoline-propelled motor rail-cars on railroad systems on a considerable scale, the author expresses his views on certain technical problems involved in the construction of such cars. The problem of the transmission of power from the engine to the axle is mentioned as presenting some difficulty, and the advantages of the electric drive are pointed out.

MAKING SPRINGS FOR MOTOR VEHICLES. By Fred H. Colvin. Published in *American Machinist*, April 3, 1924, p. 509.

The operations discussed in this article include the testing of the steel to be used in making springs for motor vehicles and the finding of the best heat-treatment for it, methods of forming eyes and bending curves and assembling and testing springs for deflection.

ADVANCED PRACTICE IN ANTI-FRICTION BEARINGS. By P. B. Liebermann. Published in *American Machinist*, April 10, 1924, p. 533.

A comparison is made between a well-designed plain bearing and an anti-friction bearing, and the following points in favor of the latter are enumerated: (*a*) less space required, (*b*) simpler housing design, (*c*) no running-in required, (*d*) starting friction practically the same as the running friction, (*e*) less friction loss, (*f*) saving in lubricant and (*g*) greater certainty of operation. A saving in power of

(*Concluded on p. 26*)

ANNOUNCEMENT

On March 31st, 1924, in the case of the American Chemical Paint Co. vs. C. R. Wilson Body Company, Detroit, Mich., the United States District Court of Delaware decided that the Feidt Letters Patent covering the manufacture of Deoxidine are valid.

Mixtures of alcohol and phosphoric acid, with or without some other ingredients, whether made or purchased, are infringements under this decision.

Notice is hereby given that all infringements of the above patent will be vigorously prosecuted for profits and damages and are subject to injunction.

Percy C. Feger
Augustus B. Stoughton
Attorneys

American Chemical Paint Co.

Detroit Office and Warehouse
137 WOODBRIDGE ST., E.

General Offices and Factory
AMBLER, PENNA.

Protect the Paint that Protects your Product

Balloon Tires? . . .
Yes, sir! Tested? *Beyond any question.* Economical? *Very.* Dependable? *As only Goodyear Tires can be.* For new small diameter wheels? *Of course.* For wheels now on your car? *As you prefer.* Which should you buy? *Your Goodyear Dealer will tell you.* His stock? *Complete with Goodyear Balloons of both kinds.*

Goodyear Means Good Wear

GOODYEAR

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NOTES AND REVIEWS

Concluded

from 40 to 50 per cent under average service conditions is claimed for anti-friction bearings. To illustrate their various characteristics, a few typical applications are mentioned, including conveyor equipment and electric motors.

ALLEVIATION AND REMEDY OF STREET CONGESTION. By Harland Bartholomew. Published in *Engineering News-Record*, May 1, 1924, p. 766.

Unscientific street plans, left-hand turns at strategic points, parking during rush hours and angular instead of parallel parking are some of the features of the traffic problem that are adversely criticized in Mr. Bartholomew's article on the subject. Methods of increasing street space are discussed, and the conclusion is reached that the enormous expense involved is often without economic justification. If the maximum use of existing street space is secured and the volume of non-essential traffic in congested areas is reduced, it is believed that the problem of street congestion will be solved for a considerable number of years, and beyond that point business must be decentralized. This may come about in several ways; an ever-increasing number of business centers may be developed in various parts of the city's area or the huge central business district must be flattened out by rigid height restriction and spread over an increasingly greater area. The author believes that, for the establishment and enforcement of permanent policies on the traffic problem, a separate commission that should be charged with the duty of studying the problem and that should have full responsibility in handling traffic should be created.

Two tables accompany the article, one giving an analysis of traffic in Chicago, St. Louis, Pittsburgh and Minneapolis; the other showing the relation of cost of relief to service.

URBAN TRANSPORTATION. A group of papers presented at the Third Midwinter Convocation of the Western Society of Engineers, February, 1924. Published in *Journal of the Western Society of Engineers*, March, 1924.

The papers presented at the Third Midwinter Convocation of the Western Society of Engineers deal with the subject of urban transportation as exemplified in the city of Chicago. An analysis is made of pedestrian, motor-car, taxicab, motor-bus, rapid transit and surface lines traffic.

The following is a list of the papers: Pedestrian Traffic, by Hugh E. Young. Second Story Sidewalks, by J. H. Sawyer. Sidewalk Subways for Downtown Chicago, by T. L. Condron and Chester L. Post. Private Auto Traffic, by Z. C. Elkins. Cab Traffic in Chicago, by William G. Beard. Motor-bus Traffic in Chicago, by J. A. Emery. Transportation and the Chicago Plan, by Eugene S. Taylor. Steam Railroad Suburban Transportation in Chicago, by F. E. Morrow, R. H. Ford, C. H. Mottier and A. W. Newton. Rapid Transit and Interurban Transportation for Chicago, by Britton I. Budd. Surface Lines Transportation in Chicago, by Charles V. Weston.

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THE

JOURNAL
OF THE SOCIETY OF
AUTOMOTIVE ENGINEERS

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HENRY M. CRANE, *President* COKER F. CLARKSON, *Secretary* C. B. WHITTELSEY, *Treasurer*

Vol. XIV June, 1924 No. 6

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The modern crankshaft must possess the attributes of a mighty, unfailing strength and be perfectly constructed to withstand the merciless toll exacted by millions of tireless revolutions.

WYMAN-GORDON

The Crankshaft Makers

Worcester, Mass. Harvey, Ill.

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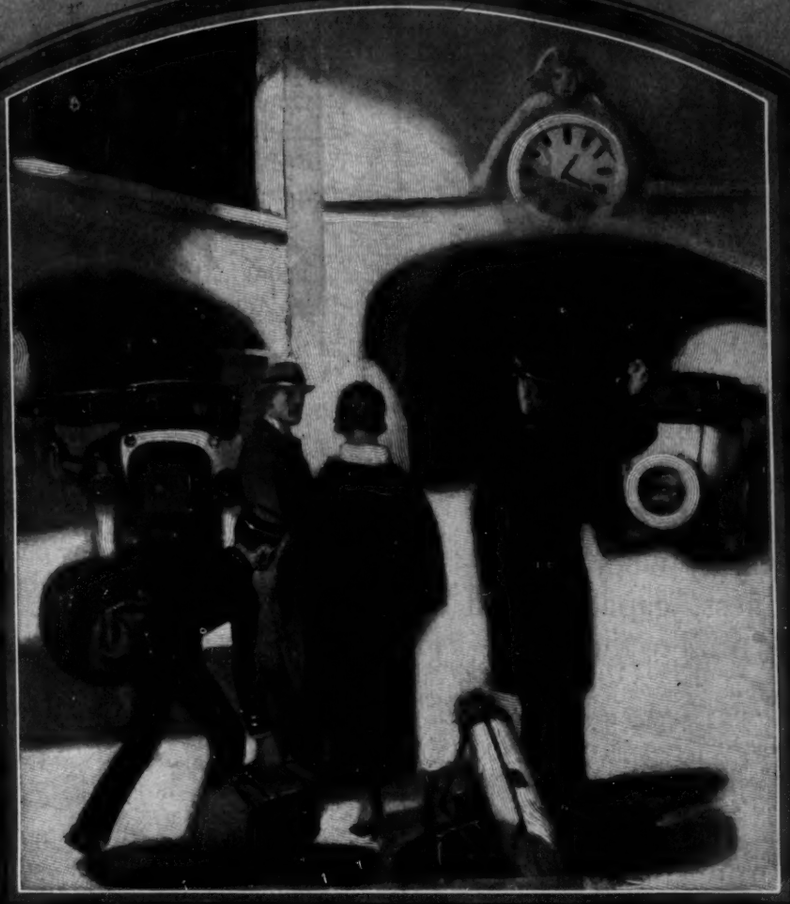

It is noteworthy that Smith Frames very decidedly have the preference in the minds of both designers and cab operators—those men who, undoubtedly, have the keenest appreciation of *endurance* in all motordom.

A. O. SMITH CORPORATION
Milwaukee, Wisconsin
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Ball Bearings of Distinction

THE quality of Gurney Ball Bearings is evidenced by the millions of Gurney bearings made and sold for use in motor cars of the highest quality where refinement, smoothness, capacity and service are essential to the success of those cars.

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Gurney Maximum Service—Maximum Capacity Ball Bearings solve bearing problems.

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S. A. E. Employment Service

The Society has determined that it can assist its members to better advantage in the matter of employment service by discontinuing the notices of Men and Positions Available, formerly published in THE JOURNAL, and establishing instead a system of Semi-Weekly Bulletins, to be sent to members upon request.

Through this Bulletin Service, which has been in effect for some time, excellent results have been obtained.

The Society keeps in touch with approximately 1000 companies in the industry. Bulletins containing notices of Men Available are mailed regularly to General Managers who are interested in receiving them.

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Motor Cars
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Contact is also maintained with technical schools and publishers of trade magazines.

Men registered as Available for employment include

General Managers and Technical Assistants
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When requesting that bulletins be sent to you, please specify whether you wish the bulletin of Men Available or that of Positions Available.

Address: S. A. E. Employment Service
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Sections Secretaries receive the Bulletins regularly.

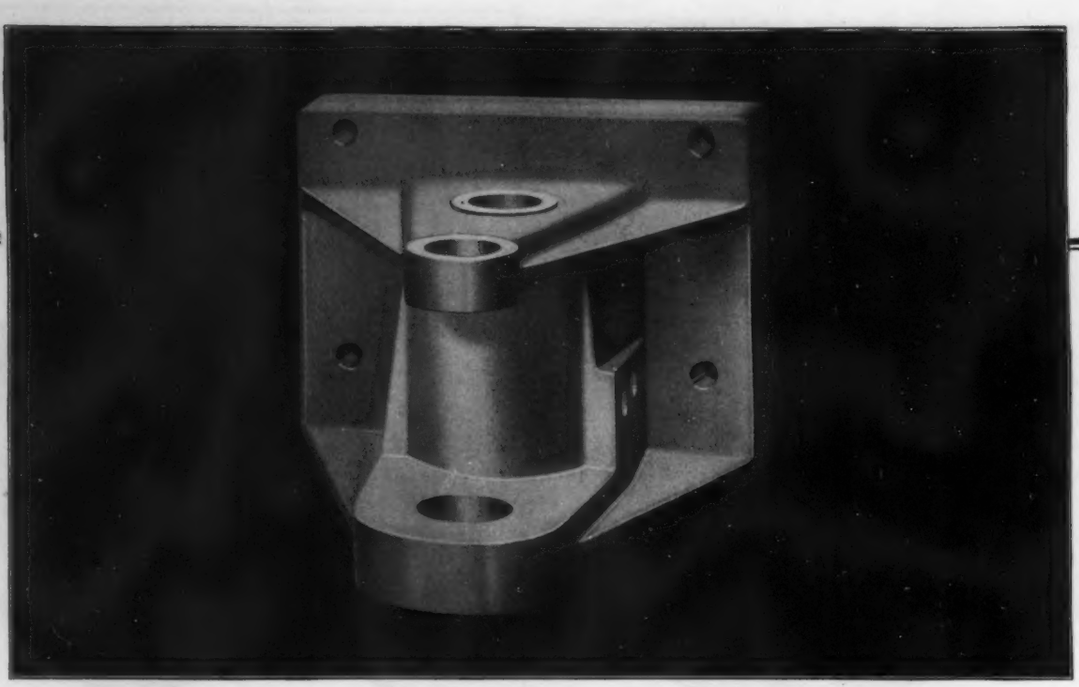
Don't give any man the opportunity to "knock" your car because he had some trouble with the equipment.

It is best to be sure that the car you sell has equipment that won't give trouble.

Stewart

VACUUM TANK AND SPEEDOMETER

ARE GIVING SATISFACTORY SERVICE ON 9 MILLION CARS



"Can you die-cast this heavy piece successfully?"

"Yes," our engineering department told the manufacturer after careful study. "We can reduce the cost of machining to almost nothing."

And we did. The dies were made with utmost precision. The conditions under which the product was used were carefully considered and a formula for a special alloy worked out. Then the casting was made. It weighed 8 lbs. 12 oz. From every standpoint it was perfect—accuracy—durability—appearance.

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4. Milling bosses inside
5. Tapping three ¼-inch holes
6. Tapping two ⅜-inch holes
7. Pressing in four bushings
8. Line ream after pressing in bushings

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Come to Stewart; state your problem; send your blueprints. The knowledge and service of our engineering department is yours for the asking. It may discover big savings for you.

If you already use die castings, consider the vital importance of—

1. The manufacturer's knowledge of alloys. Upon that knowledge depends the ability to determine the best metal to use in *your* castings.
2. Even most intricate castings must be produced in quantity with dependable *accuracy*.
3. What recourse have you if the manufacturer, to whom you have entrusted your dies, fails to make deliveries?

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Manufactured by

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INCORPORATED

LONG ISLAND CITY, N.Y.

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Automobile, Truck and Tractor Companies:

Boyce-ite, as its history shows, actually eliminates all carbon troubles, does away with the carbon knock, and removes forever the necessity of grinding valves, etc.

If you will test Boyce-ite on a car from one to fifty thousand miles, you will agree with me that Boyce-ite Treated Gasoline is the only fit fuel for an internal combustion motor.

Won't you accept with my compliments a quantity of Boyce-ite for test in your personal car or in your laboratory?

If Boyce-ite is one-half as good as I know it to be, it's the greatest boon the industry has known for a long time.

If you will write me, "send your sample of Boyce-ite," I will gladly see that you are supplied, gratis. All I ask in return is that after the test you will write me of your findings.

Cordially yours,

hhb:v President

fits in the Door Pocket or Tool Box

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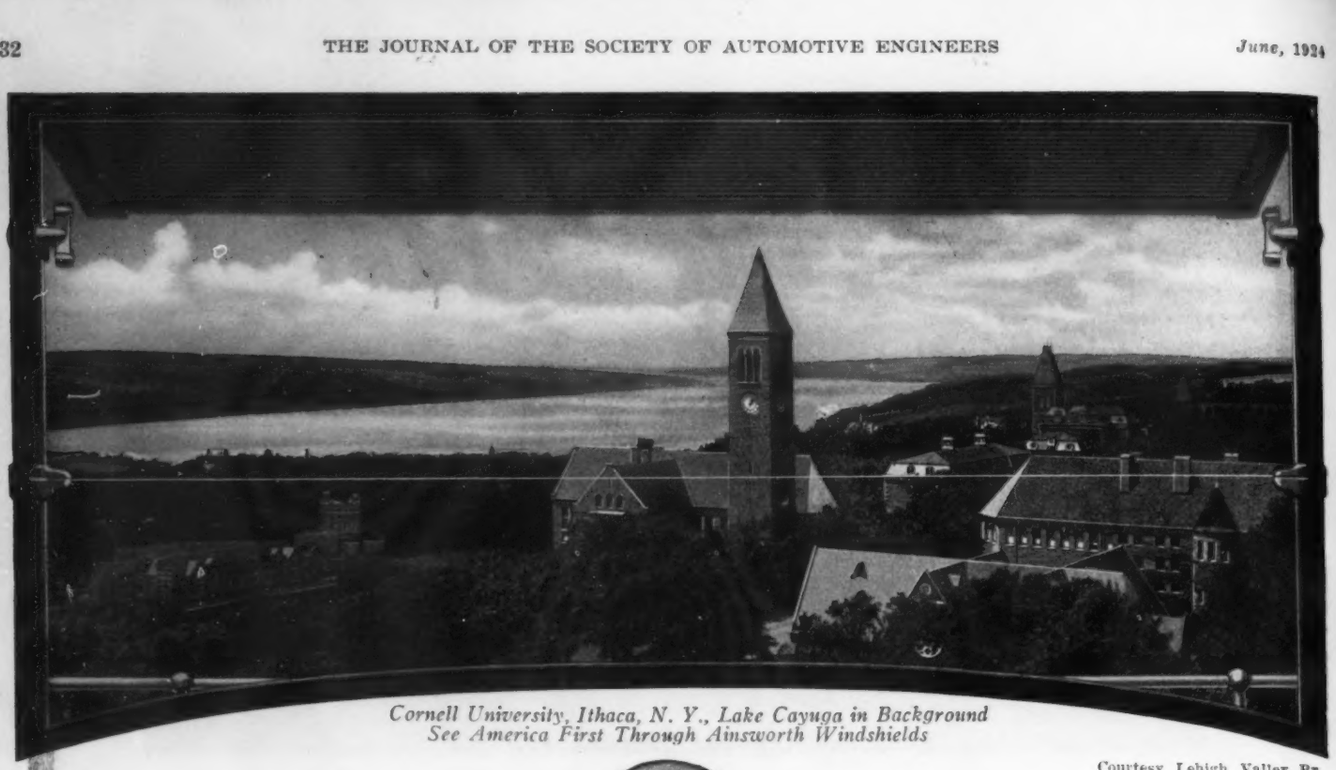
4,419,878 CANS



Cornell University, Ithaca, N. Y., Lake Cayuga in Background
See America First Through Ainsworth Windshields

Courtesy Lehigh Valley Ry.

EDUCATION

Each year the motoring public is becoming more conscious of the necessity for safety. It is primarily a matter of education.

Ainsworth Windshields and Visors are constructed to provide correct driving vision. In so doing they become a positive factor of safety.

Motor car manufacturers and owners apparently recognize this quality, hence the ever increasing demand for our products.

The Ainsworth
WINDSHIELD AND VISOR

AINSWORTH MANUFACTURING COMPANY
DETROIT, MICHIGAN

Tested

by Underwriters' Laboratories

RECENTLY Dayton Steel Wheels were subjected to the exacting tests and examinations of the Underwriters' Laboratories. Here, Dayton Steel Wheels were placed in huge machines to undergo Radial Static, Lateral Static and Lateral Impact Strength Tests. Wheels of various sizes were examined and tested for their Durability, Practicability, Uniformity of Manufacture and Record in Service.

Dayton Steel Wheels passed through all of these tests and examinations with colors flying. The Underwriters' Laboratories unreservedly accepted as Standard the wheels that have successfully passed their technical tests and that have proven by the service they are rendering in all classes of work in all climates that they are "The Final Wheel for the Motor Truck."

There is a Dayton Steel Wheel for your particular requirement. Specify them for long-life insurance and increased earning capacity for your trucks.

The Dayton Steel Foundry Co., Dayton, Ohio

Dayton

Steel Truck Wheels

DON'T we, all of us some of the time, and some of us all the time, give our transmission gears a razzing when we shift?
"Van Dorn" Gears stand the gaff of rough treatment.
The Van Dorn & Dutton Company
Gear Craftsmen for over a Quarter Century
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Imagine an automobile with the power of Niagara Falls—a four million horse power car! Yet one month's output of Harrison Radiators would cool it.

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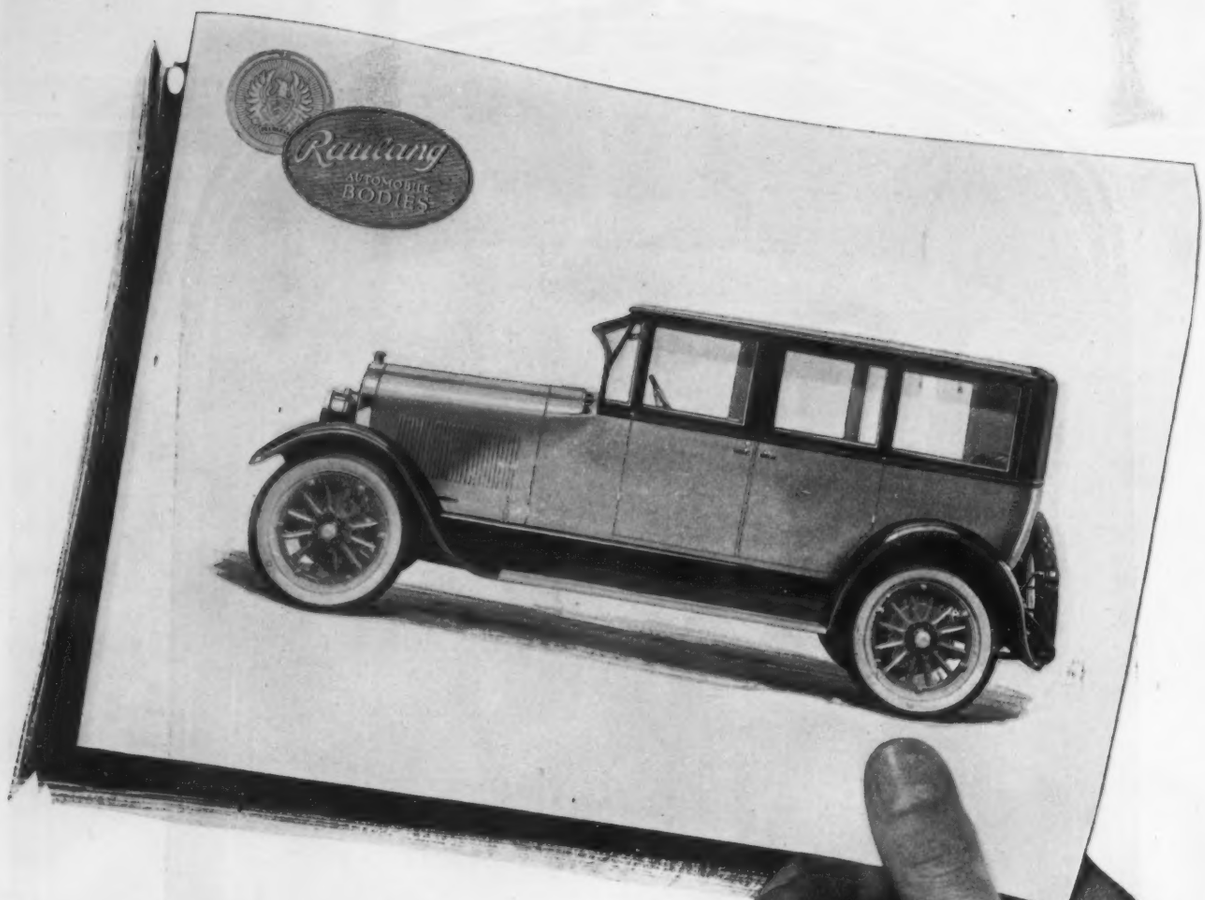
HARRISON RADIATOR CORPORATION, LOCKPORT, NEW YORK

HARRISON COOLED

THE MARK OF RADIATOR SATISFACTION



Peerless plus Raulang

Owners will tell you that the Peerless record is singularly free from false judgments in the selection of parts and equipment. It means something, then, that—

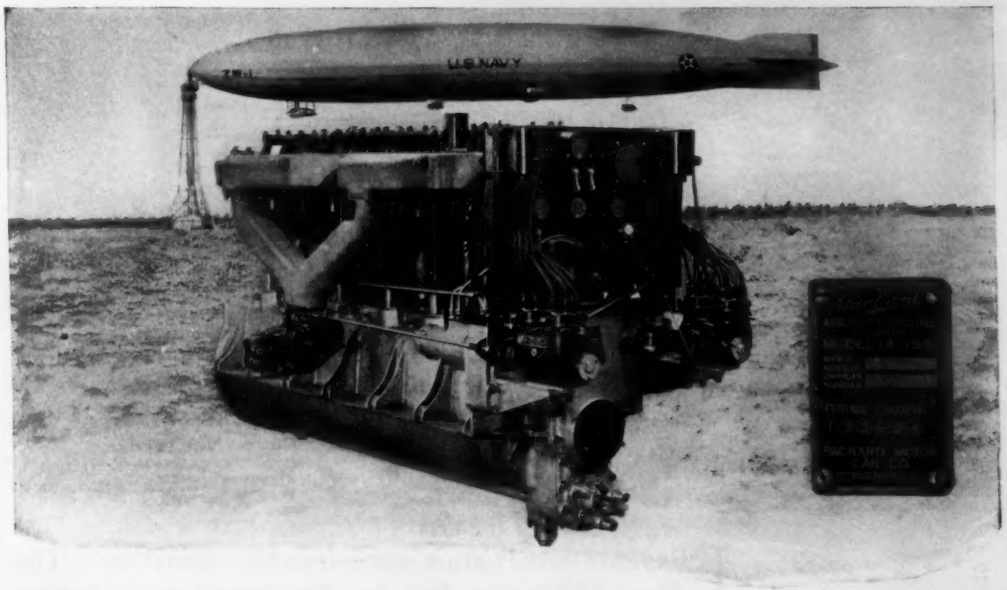
All the new Peerless Six closed bodies are Raulang-built!

This splendid endorsement of Raulang quality is added to a long line of other notable tributes. The Raulang reputation is solidly established on *seventy consecutive years* of coach-building experience.

Add to that: (1) adequate financial resources, (2) ample floor space and facilities, and (3) an unbroken record of delivery promises kept—these are the *values* that a car manufacturer finds in the Raulang contract!

RAULANG BODY DIVISION of THE BAKER R & L CO., CLEVELAND, OHIO, U. S. A.

SKF



Six 300 H. P. Motors of ZR-1

Ball Bearing Equipped

THE remarkable performance of America's Queen of the Air is due in no small measure to the unfailing service of the six 300 H. P. motors. Under all conditions—in the teeth of gales—the safety of the big ship demands that every ounce of power developed in the motors be delivered to the propellers.

SKF marked ball bearings on the compression releases, governor and oil pump driving shafts of each motor, do their share to insure safe navigation. Their use on the oil pump—the critical point of the oiling system—guards against bearing failures which would prove a serious handicap in emergencies.

The superior performance and great endurance of **SKF** marked ball bearings on the ZR-1 is reflected in other fields through their extensive use on automotive, railway and industrial equipment. Our engineers will gladly point out how ball bearings on your equipment will insure the same degree of precision as on the ZR-1.

THE HESS-BRIGHT MANUFACTURING COMPANY

Supervised by **SKF** INDUSTRIES, INC., 165 Broadway, New York City

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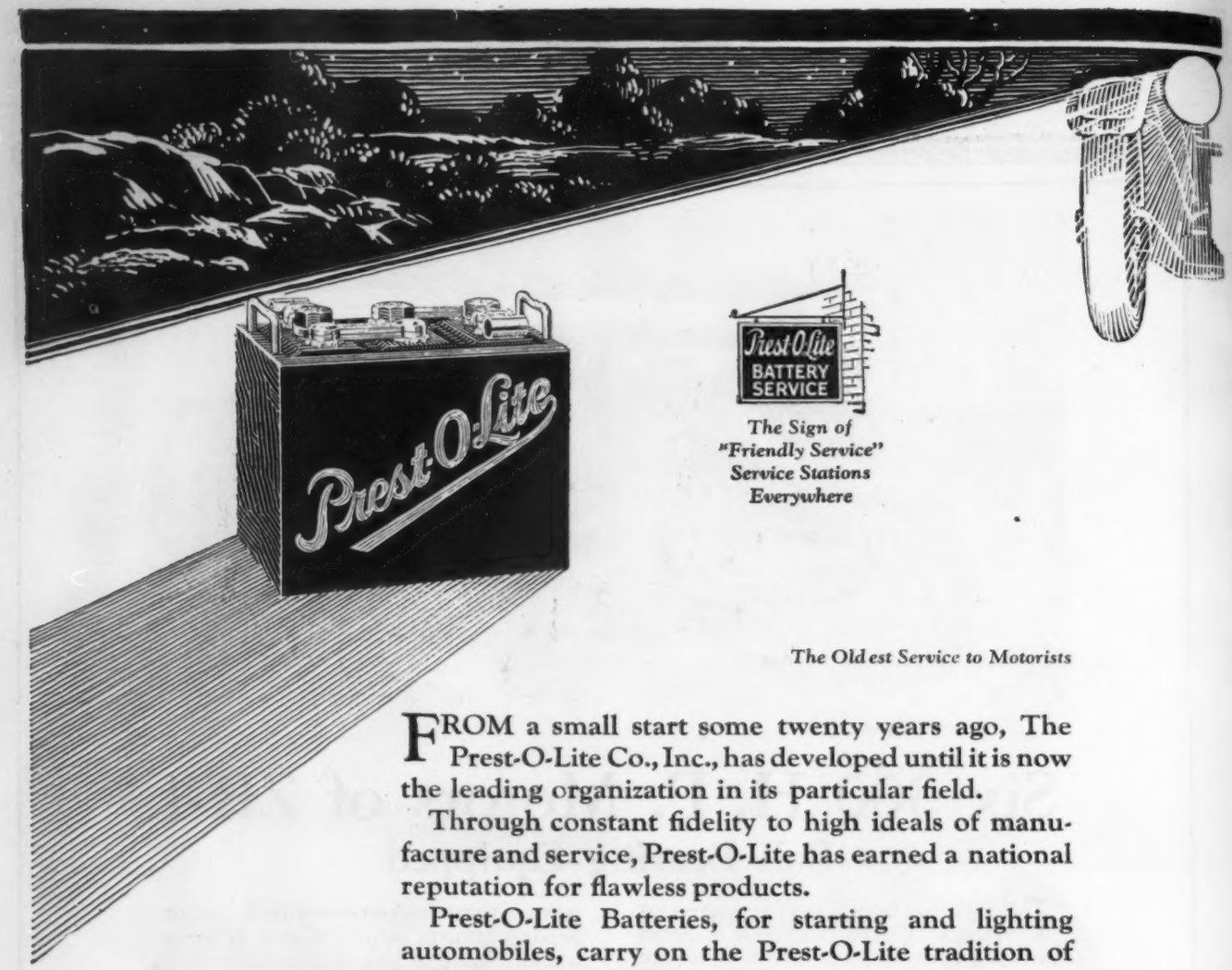
Cross Section of Single-Row Bearing

Cross Section of Double-Row Bearing



Prest-O-Lite BATTERY SERVICE

The Sign of "Friendly Service" Service Stations Everywhere

The Oldest Service to Motorists

FROM a small start some twenty years ago, The Prest-O-Lite Co., Inc., has developed until it is now the leading organization in its particular field.

Through constant fidelity to high ideals of manufacture and service, Prest-O-Lite has earned a national reputation for flawless products.

Prest-O-Lite Batteries, for starting and lighting automobiles, carry on the Prest-O-Lite tradition of unfailing dependability.

They are today standard equipment on a large and constantly growing list of America's famous automobiles.

Prest-

The Sign of Universal Gas Service

The Gas of a Thousand Uses

THE exacting requirements of truck operation necessitate a lighting system that is unaffected by heavy vibration, jars or jolts.

Prest-O-Lite Gas gives a clear unvarying light under any road or weather conditions.

Prest-O-Lite Gas Lighting Equipment is built to meet the demands of trucking service. The certainty with which it performs has earned for it the approval of manufacturers and owners as well as public authorities.

Prest-O-Lite outlives the truck.

Thirty-six big gas producing plants supply thousands of Prest-O-Lite Exchange Stations scattered all over the country. You can always get a full tank for your empty one by paying a very small amount for the gas only.

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INDIANAPOLIS, IND.
New York: 30 East 42nd Street Pacific Coast: 599 Eighth Street, San Francisco
In Canada: Prest-O-Lite Company of Canada, Ltd., Toronto

A
Prest-O-Lite
PRODUCT
WORLD'S LARGEST MANUFACTURER OF ACETYLENE THE GAS OF A THOUSAND USES
BATTERIES FOR AUTOMOBILES, FARM LIGHTING, RAILWAY SIGNALS AND RADIO

-O-Lite

Patented
March 29, 1910
May 2, 1922

[One to a Piston]

Sooner Or Later

SOONER or later, in the life of almost every motor, there comes a time when it starts using too much oil. Far-seeing engineers are now equipping their motors with PERFECT CIRCLE *Oil-Regulating* rings at the factory, rather than pass this burden on to the car owners.

Don't play with oil pressures, or baffle plates, or high tension, *scraping* rings. Give the cylinders an abundance of oil, and then stop it at the right place, the lower ring. You can do it with the PERFECT CIRCLE *Oil-Regulating* ring.

Let PERFECT CIRCLES solve your problem, and quit worrying about it. Forty-eight manufacturers, among them Packard, Marmon, Hupmobile and Willys-Knight are using the PERFECT CIRCLE *Oil-Regulating* ring this year as standard equipment, because they prevent oil-pumping, and give 1000 or more miles to the gallon of oil. Write for sample rings and complete information.

INDIANA PISTON RING COMPANY
Hagerstown, Indiana

PERFECT CIRCLE
Oil-Regulating Piston Rings

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Specify Latest Wheel Improvements

"Look for 'Hayes' on the Lug"

Engineers and motorists everywhere are becoming more conscious of the fact that wheel convenience adds very materially to motoring enjoyment and time saving. It is becoming more and more evident that Hayes wheels have kept pace with other motor car improvements—that they present features which place them as far ahead of the average as the latest multi-cylinder motor car over its two-cylinder predecessor.

Hayes offers wheels which are completely standardized and therefore immediately interchangeable, one with another, whether it be in wood, wire or disc. It may easily be demonstrated that Hayes wheels save one-half the usual time in making tire changes, that they eliminate rim squeaks, torn valve-stems and distribute the driving strains over the entire circumference of the wheel.

In motoring and engineering circles it is becoming more and more of a practice to look for the Attached-Lug and look for the name "Hayes" which denotes the genuine.

HAYES WHEEL COMPANY, *Manufacturers*, Jackson, Michigan

Factories: Jackson, Albion, Flint, St. Johns, Mich.; Anderson, Ind.; Nashville, Tenn. Canadian Plants: Chatham and Merriton, Ont. Export Office: 30 Water Street, New York City.

HAYES WHEELS

WITH ATTACHED LUG RIMS ~ STANDARDIZED IN WOOD, WIRE AND DISC

134

Auto-Lite has grown right up with the automobile industry—progressing as the industry progressed—keeping step with the needs of car builders, and likewise with the wishes of car buyers.

It is a twelve-year-old policy with Auto-Lite to anticipate and prepare for each year's growth a year ahead of time.

The very confidence that millions of car owners show toward Auto-Lite keeps Auto-Lite true to all its traditions of reliability.

Leadership imposes an obligation which can never be ignored.

THE ELECTRIC AUTO-LITE COMPANY
Office and Works: Toledo, Ohio

Auto-Lite

Starting, Lighting and Ignition

THE SATURDAY EVENING POST

The engineer moves the air control. Air under pressure, confined in a small space and seeking to escape, forces metal brake-shoes against the car wheels. The heavy train slows down and stops.

Air will stop a train

Confined air is a restless, mighty force

BY applying the force of air under confinement to the wheels, the longest and fastest freight or express train is made quickly to obey the will of its engineer.

This same force gives us the pneumatic tire. Held under pressure and trying to find a way to get out, air fills out the flexible rubber tube that serves to cushion shocks for automobile and passengers.

The inner tube

Two things had to be accomplished, however, before air could do its work. First, a container had to be made that would be air-tight. Then the tire-maker needed to get air into his tube and keep it there. He solved the problem by inserting a Schrader Tire Valve in every tube. The tire valve had to be air-tight, for if air escaped and his tires ran with too little air, their life would be shortened.

Why he uses Schrader Valves

Ever since pneumatic tires were first made, Schrader Universal Tire Valves have been used to retain air in them. Today these valves are standard on nearly every pneumatic tire made in this country and Canada, for the tire manufacturer knows that Schrader Valves hold air.

Every Schrader Tire Valve is thoroughly tested and rigidly inspected before it leaves the factory. The tire manufacturer tests the tube after inserting the tire valve; therefore, the car owner may be sure of receiving a tube and valve that are absolutely air-tight.

How to use the Schrader Valve

There is only one way by which you can get the full effectiveness of this tire valve and the maximum mileage out of your tires—use it complete with all its parts. On this page these essential parts are shown and described. See that your car is equipped with all these Schrader parts. If you lose a dust cap or a valve cap, put another one on immediately. Thus you care for your valve and the air in your tires at the same time and cut down your tire bills.

Avoid these air troubles

If the hexagon nut at the base of the valve is loose, air can escape there. Always tighten this nut before inserting a new tube. If you use an old, worn-out, road-racked, patched tube, you can expect trouble at any time. Replacement with a new tube equipped with the complete Schrader Tire Valve is worth the money in the security it gives and the trouble it saves.

Always have extras in your kit

For your own comfort and security make it a point never to be without extra Schrader Tire Valve parts in your tool kit. These valve parts are interchangeable, so you can be sure that a valve cap, valve inside, dust cap and rim nut bought in different parts of the world will fit the valve you own now.

Carry—*and use frequently*—a Schrader Tire Pressure Gauge. Schrader Gauges and Valve Parts on sale at motor accessory shops, garages, and hardware stores.

A. SCHRADER'S SON, INC., BROOKLYN, N. Y.
CHICAGO TORONTO LONDON

Complete SCHRADER TIRE VALVE with Dust Cap as it appears on tires in actual service.

This is the SCHRADER DUST CAP that goes over the valve and protects it and the valve stem threads. Can be attached or detached with a few turns of the hand.
Under the Dust Cap and on top of the valve is—

Dust Cap

The SCHRADER VALVE CAP. Through this cap, when screwed on by hand, no dirt can enter the valve, and no air can escape from the tube.
Protected by the Valve Cap is—

Valve Cap

The SCHRADER VALVE INSIDE, which is placed in the mouth of the valve. It permits quick entrance of air, and also prevents escape of that air once it is in the tube.
The valve stem into which the Valve Inside goes is centered in the valve hole by—

Valve Inside

The SCHRADER RIM NUT BUSHING, which also holds on the Dust Cap. It is always tightened against the wheel by a small wrench.

Rim Nut Bushing

This is the SCHRADER TIRE VALVE with all its parts in place except the Dust Cap. You also see here the Hexagon Nut screwed against the Bridge Washer at the base of valve.
Add the Dust Cap and you have the complete Schrader Valve which should be on your tires.

Complete Schrader Valve

Schrader

Makers of Pneumatic Valves Since 1844

Tire Valves · Tire Gauges

Reproduction of advertisement which recently appeared in the Saturday Evening Post

You Know That

Cap Screws made by the "Up-Set" or Cold-headed process must be heat-treated to insure a uniform product.

That is why Ferry Process Screws have been giving unequalled service for seventeen continuous years.

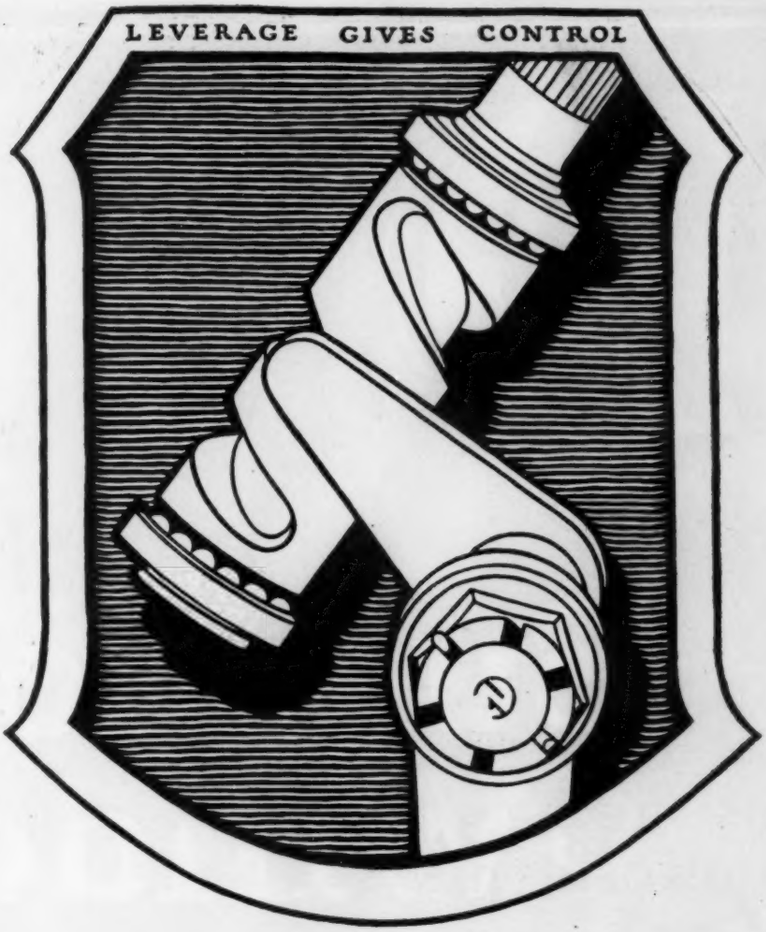
Write for prices.

"If It's Up-Set It Must Be Heat-treated"

The Ferry Cap and Set Screw Company, Cleveland Ohio

FERRY

PROCESS SCREWS



YOU STEER *ALL* THE TIME

WHEN you drive an automobile, you've got to steer all the time. This physical strain, now increased by balloon and balloon-type tires, is being realized by car-owners. Easier, better steering is being demanded—and Ross *supplies* it!

Write for the facts

ROSS GEAR AND TOOL COMPANY, *730 Heath Street,* Lafayette, Indiana

ROSS

CAM *and* LEVER STEERING GEARS

EASIER STEERING LESS ROAD SHOCK

DU

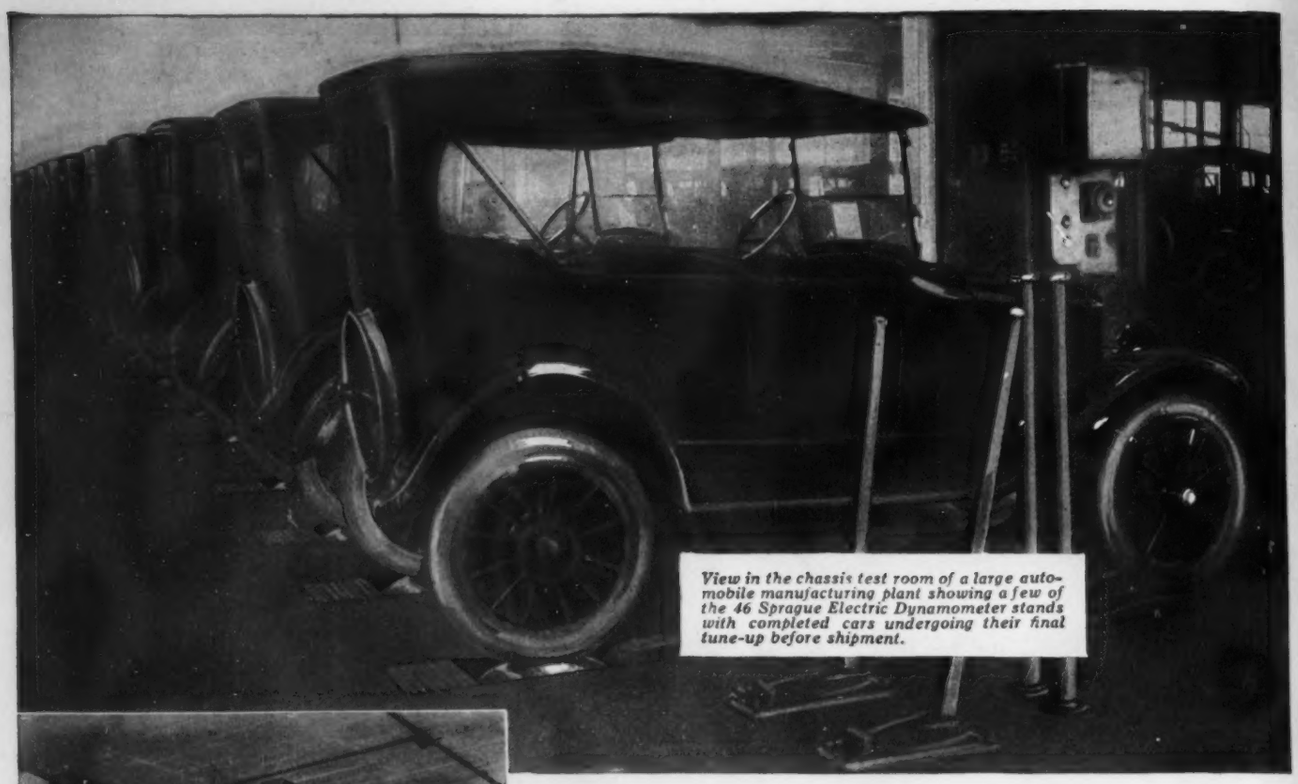
Supplies A Window That Completely

DURA has perfected a complete system of closed car window regulators — a logical type for each different need.

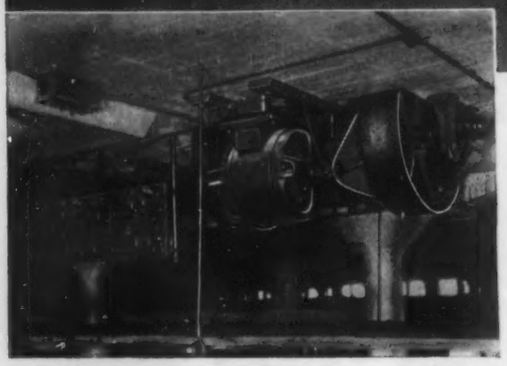
The Lever Type for the driver's window—protection from accidents—instant signalling—one easy split-second up and down stroke completely opens and closes. A Dura quick-acting Lever Type on the driver's window is just as important as having a driver's window!

The more decorative Crank

RA
System of
Regulators
Meets Every Need
Type for other doors where easy, effortless action rather than speed is essential.
The Clement Type for rear quarter windows—an exclusive Dura type that has no projecting handles to tear clothing or induce discomfort.
This Dura Window Regulator System is the logical selection where the complete satisfaction of the car owner is sought.
Interior Fittings
The DURA COMPANY, Toledo, Ohio
Window Regulators



View in the chassis test room of a large automobile manufacturing plant showing a few of the 46 Sprague Electric Dynamometer stands with completed cars undergoing their final tune-up before shipment.



The Sprague Chassis-Test Dynamometer is easy to install. It may be mounted on the ceiling below the test floor with the drums projecting through the floor so the top of the rim is approximately at the floor level. It can also be mounted in a pit.

Eliminate your road tests

Test your finished cars *in your factory*—by using the Sprague Chassis-Test Dynamometer.

This equipment tunes up the engine and transmission better than a road test—and establishes certainty of results, combined with economy of operation, which produce a better car.

It lowers cost by effecting a big saving in the test room force, in tires, in painting, and in many other factors—as compared with road tests.

The Sprague Chassis-Test Dynamometer is already used by leading automobile manufacturers. It is suitable for test of both small and large cars. This equipment is readily installed and easily operated.

Ask the G-E Sales Office nearest you for complete information.

General Electric Company
Schenectady, N. Y.
Sales Offices in all Large Cities

Cars which are thoroughly tested before reaching the owner—give greater satisfaction

405-230

GENERAL ELECTRIC

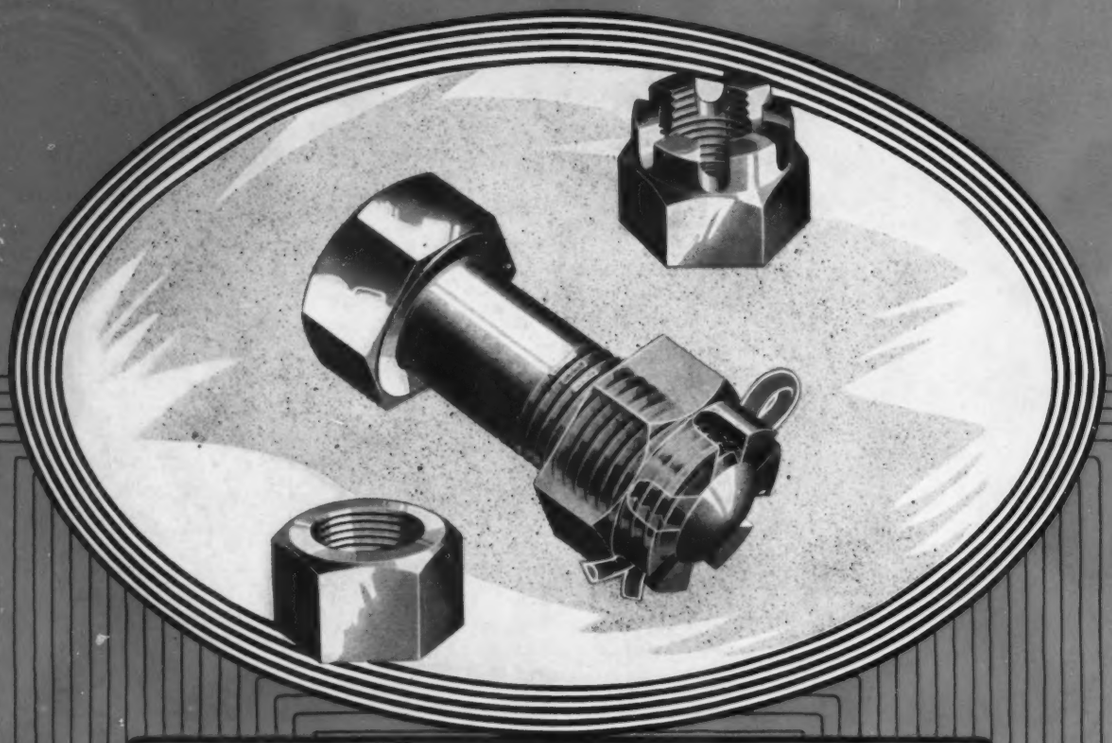
In Good Repute with Automotive Engineers

EACH year additional names are added to the list of motor car and motor truck manufacturers including Packard Cable as a standard factory specification.

1924 will be no exception, and our list of 119 motor vehicle manufacturer customers will increase to a new and even more impressive figure.

Engineers recognize Packard Cable as a specialized unit which contributes to efficient motor car performance.

The Packard Electric Company
Warren, Ohio



Do you really specify—

or take what you get?

When you call for Nuts and Screws of a certain size to S. A. E. specifications, what percentage of the product you get really measures up to this high standard?

Does the manufacturer follow the specifications "generally" or specifically?

Every Screw or Nut that falls short of being right either adds to assembly time or finds its way to the scrap pile. In either case you are taking chances and piling up unnecessary cost.

NAMCO S. A. E. Nuts are Milled-from-the-bar, they are tapped straight, the threads are clean and true to lead, they are smoothly faced and chamfered, the slotted edges are not ragged. They are strong and of uniformly good quality whether you buy a thousand or a million.

Specify NAMCO Milled Nuts.

The National Acme Company

Cleveland New York Boston Buffalo Detroit Chicago

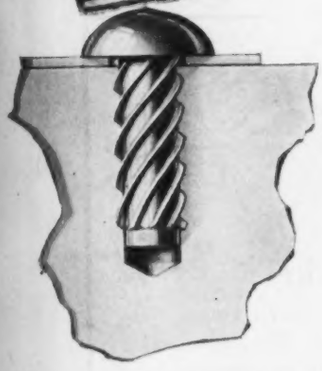
Drill the Hole and Drive the Screw with a Hammer—

A New and Better Means of Making Fastenings—

to Steel, Cast Iron, Brass, Aluminum, Bakelite, etc.

Here is a Screw that is as easy to use in metal as a nail is in wood. You drill a hole—insert the tip of the Screw—hammer it home. The hardened thread cuts into the material as you drive the Screw in, eliminating the costly tapping operation. Exhaustive tests have proven that they hold better than machine screws, escutcheon pins, etc. And, since the tapping operation is done away with the cost of making fastenings is cut from 50 to 75%.

More than 2500 manufacturers have already adopted them. Practically every metal working plant can and will use them eventually. See whether they are adapted for your work. Use the coupon for FREE SAMPLES.



Showing a Hardened Metallic Drive Screw driven into cast iron. The screw is so hardened that it cuts into the material without stripping or injuring its thread.

Parker-Kalon

Hardened Metallic

Drive Screws

(Pat. Jan. 29, 1924)

The Driving Qualities of a Nail+The Holding Qualities of a Screw

PARKER-KALON CORPORATION
358 West 13th Street, New York
Agents for British Isles: Charles Churchill & Co., Ltd., Finsbury, London, E. C. 2, England

PARKER-KALON CORP.,
358 West Thirteenth St., New York City

Gentlemen:

We wish to try Hardened Metallic Drive Screws for .....
(Mention application you have in mind.)
We are now using for this purpose .....
(State whether you use escutcheon pins or machine screws and what sizes.)

Send us samples of Hardened Metallic Drive Screws in the nearest sizes you make to the sizes of escutcheon pins or machine screws we have specified.

Firm Name .....

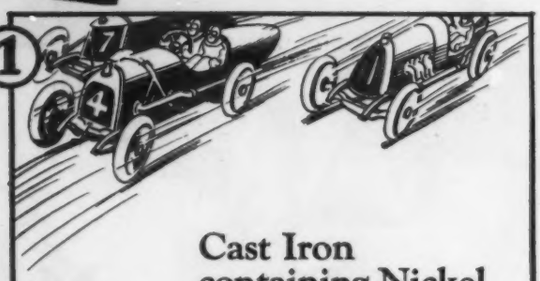
Address .....

City..... State.....

Mark attention of Mr. .....

4 points of Superiority

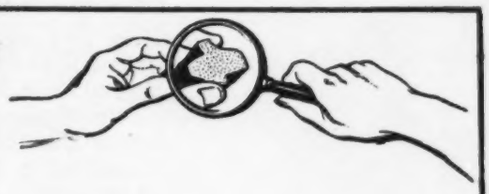
~gray iron castings containing grade F Nickel increase engine mileage



Cast Iron containing Nickel
has increased wearability.
(Comparative tests have shown an improvement of 50% to 100% in wearing qualities.)

Cast Iron containing Nickel
has greater uniform hardness with no increase in brittleness.
(This hardness is absolutely regular—not spotty and troublesome.)

Cast Iron containing Nickel
has consistent grayness.
(This reduces manufacturing costs, flinty white spots, which cause machining difficulties, being eliminated.)



Cast Iron containing Nickel
has a finer, closer grain.
(Examination of a Nickel-cast iron cross-section shows this clearly.)

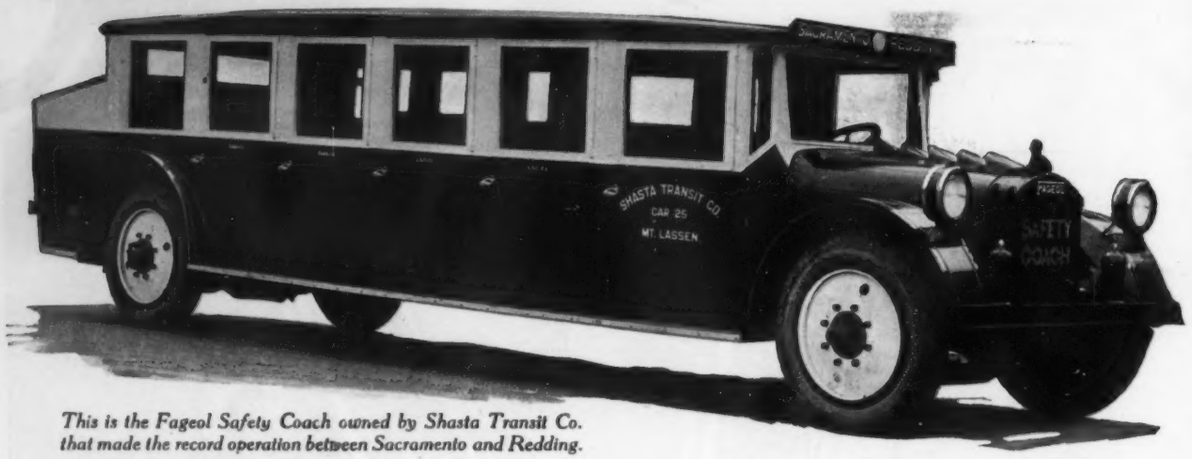
Improved quality pays for itself. Write for information about our Grade F specially developed Nickel for use in Cast Iron. Write today!

INCo

Nickel

THE INTERNATIONAL NICKEL COMPANY, 67 WALL STREET, NEW YORK CITY.

Outside
Door
Handles
Steel reinforced die cast construction—Priced right and delivered on time—
Send for samples and prices.
SOSS MFG. CO., Inc.
BROOKLYN, N. Y.
Detroit Offices, 535 Book Bldg.
SOSS



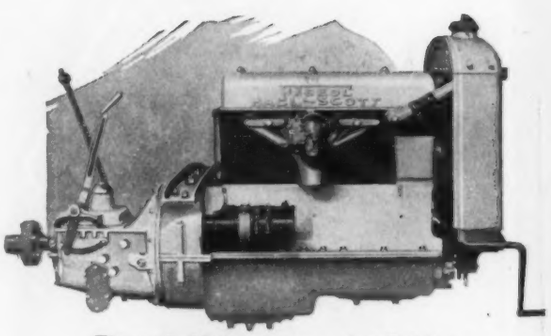
This is the Fageol Safety Coach owned by Shasta Transit Co. that made the record operation between Sacramento and Redding.

120,000 Miles Without Bearing Replacement A Federal Mogul Record

The Shasta Transit Co. maintained their schedule between Sacramento and Redding by means of three cars, two cars making a one-way trip each day. Because emergencies did arise, it was always necessary to hold a third car in reserve.

One Fageol Safety Coach now does the work of those three cars. It makes a round trip every day, 350 miles with plenty of detours. It has been maintaining this grueling schedule since January 16, 1923. It has piled up a mileage of over 120,000 miles and in all that time the Federal-Mogul bearings have given perfect service and have never had to be replaced.

These tests prove the superiority of Federal-Mogul Bearings. That is why more Federal-Mogul Bearings are used for standard equipment than any other kind.



This is the Hall-Scott power plant that drives the Fageol Safety Coach. Main and connecting rod bearings are all Federal-Moguls

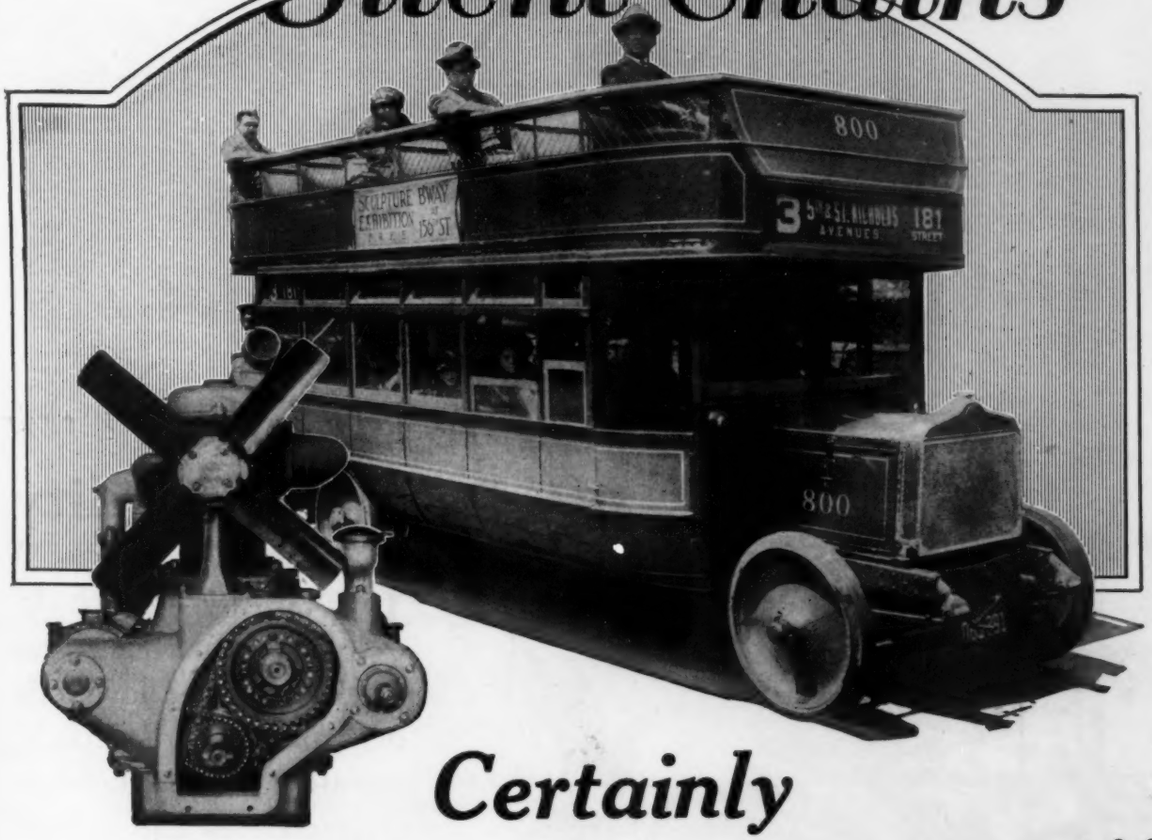
FEDERAL-MOGUL CORPORATION

Successors to MUZZY-LYON CO. and the
FEDERAL BEARING AND BUSHING CORPORATION

DETROIT, MICH.

"WHITNEY"

Silent Chains



"WHITNEY" Silent Chains are standard equipment on most buses in operation today.

Certainly a severe test!!

Thousands of these buses moving day and night on city streets and along the main highways, depend on "WHITNEY" Silent Chains to keep their engines operating.

The worth of a chain is proved beyond question in this kind of a test. "WHITNEY" chains are built for service and give greater mileage.

There is a "WHITNEY" Silent Chain for nearly all cars, any model.

THE WHITNEY MFG. CO.

HARTFORD CONN.

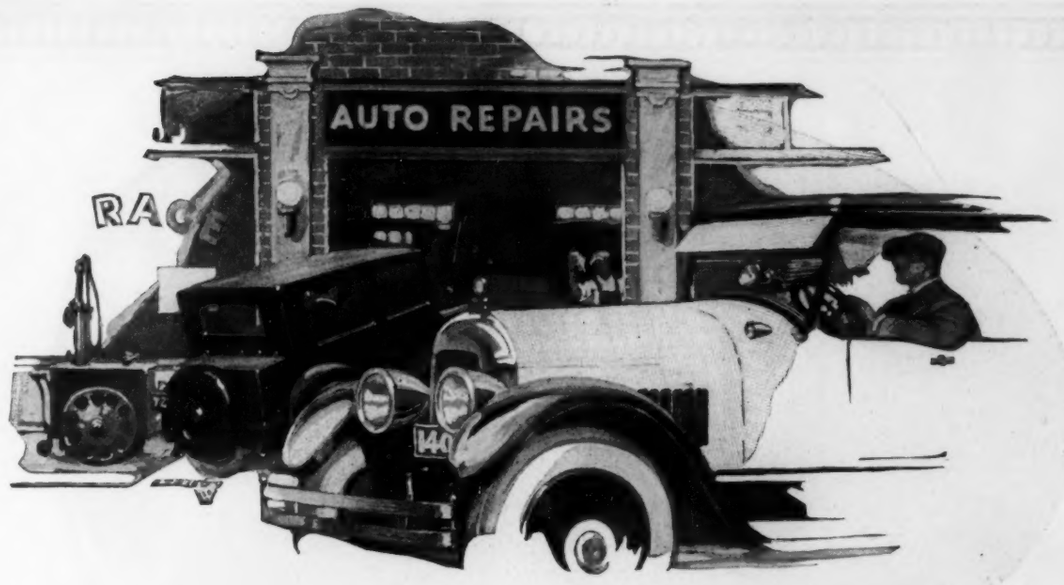
ATWATER KENT

Makers of
THE WORLD'S HIGHEST GRADE IGNITION
STARTING AND LIGHTING

Unfailing Dependability

UP SHARP, steep hills, around hairpin curves or down in the lowlands over rolling country roads, unfailing dependability characterizes the motor performance of the car whose standard equipment includes ATWATER KENT Ignition.

ATWATER KENT MFG. CO.
4961 STENTON AVE. PHILADELPHIA, PA.



Is Your Motor Car a Liability— Or An Asset

Most motoring grief comes from one cause now easily remedied

Last year the American public paid over $2,400,000,000 for new cars—and upwards of $5,000,000,000 for upkeep. Are you doing a thriving business in replacement parts at the expense of new car sales?

If you manufacture a popular make of car, it must be good or it would not be popular. But no matter how good it is, it can't *remain* popular if it is a source of repairs for the owner.

And 80% of all repairs, as you know are due to one cause—*nothing but lack of proper lubrication.*

The Weak Point

Most motorists take good care of the engine. Because its easy. And they have learned the need of changing crank case oil through the helpful efforts of Oil Companies. It's the 20 to 60 hard-wearing dust exposed chassis bearings they are apt to neglect.

That's why most of the leading makes of fine cars in the United States and Europe are now standard-equipped with the Alemite System of chassis lubrication. (Over 4,000,000 now in use.)

The Human Equation

It takes high pressure lubrication to keep chassis bearings clean and well lubricated. It takes a system easy to operate, or the average motorist will neglect it. And it takes one they are *educated* to use—or they will overlook regular use.

Alemite advertising has made use of the Alemite system—every 500 miles—as vital a part of motor care as oil, air and water.

Alemite service in 20,000 stations, the country over, makes it just as easy and convenient as crankcase service.

That's why so many repair men will tell you that Alemite is the best means for keeping down repairs. And the one system of lubrication that gets *regular* use under *actual* working conditions.

Hundreds of thousands of motorists who replace other systems with Alemite each year, at their own expense, prove the growing importance of chassis lubrication in the public mind.

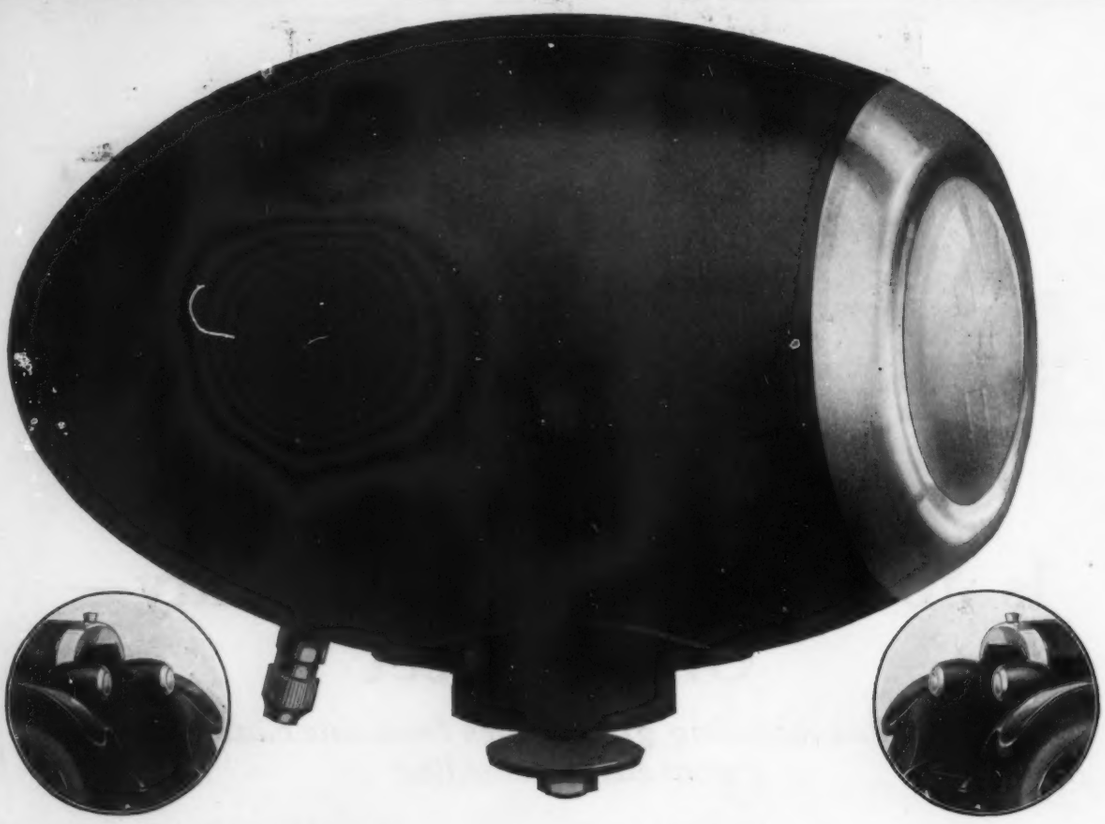
THE BASSICK MANUFACTURING COMPANY
2654 North Crawford Avenue, Chicago, Illinois
Canadian Factory: **Alemite Products Co., of Canada, Ltd., Belleville, Ontario**

A Bassick-Alemite Product

ALEMITE

"Reg. U. S. Pat. Off."

High pressure lubricating system



How Motor Car Manufacturers Can Assist In Making Night Driving Safe

After four years of diligent research, the I. E. S. and the S. A. E. have formulated specifications covering automobile headlights which, if met, are ideal from every standpoint.

The E & J Type 20 Headlight meets these exacting specifications in every regard. Therefore, it behooves motor car manufacturers to lend their influence in this solution of night driving safety by adopting a lamp that measures up to the prescribed standards.

The E & J Type 20 Headlight is "The Safest Light in Motordom" for the following reasons:

It illuminates the road with a uniform light from source to hundreds of feet ahead.

It does not glare, due to amber toned upper rays.

It never has to be dimmed.

It can be aimed and focused to meet the lighting laws in every state.

It projects a strong light beyond point where approaching headlights become a menace.

It is equipped with standard S. A. E. bracket for mounting.

It makes night driving safe.

Do Your Part to Enforce Correct Automobile Lighting

EDMUNDS & JONES CORPORATION
DETROIT, MICHIGAN
"The Safest Light in Motordom"

(Manufactured under Bone Patent, 8-30-21 and 1-15-24, other Patents Pending)

Rubber
and
Your Automotive Problems

Has it occurred to you that the same unique properties of *rubber* which underlie the success of the automobile tire have numberless other possible applications in the Automotive Industry?

The advantages of *rubber* for wear resistance are well realized, but few appreciate its further valuable possibilities to provide a strong flexible part; to eliminate noise; to overcome friction or, on the contrary, to prevent slip; to resist acid, moisture and rust; to remove the necessity of greasing and oiling; to replace wood or metal.

Some problems solved or being solved are:—

Flexible Universal Joint Disc.—Of rubber and fabric, presents a new engineering solution for this troublesome problem, eliminating the friction and attendant lubrication unavoidable in the metal joint.

Rubber Shackles—Does away with the constant wear, vibration and greasing of shackle joints.

Channel and Strip Rubber—Eliminates the annoyance of rattling windows and glass, or provides non-binding runways for windows and seals joints against squeaks or weather. Witness the covered rubber channels, windlace tubing, windshield strips, rubber strips for setting glass in frames.

Hard Rubber Garnish Molding—The value of hard rubber for window trim, tops of seats, tops of side-frames in open cars, etc., is only just coming to be realized. It will not warp, it is impervious to moisture, takes a polished or leather finish and is pleasing to the eye and touch. There is also a growing use of hard rubber for steering wheels and other accessories.

Rubber Floor and Running Board Mats—The beauty and utility of the Rubber Running Board Mat is acknowledged, and rubber is destined to replace the ordinary carpet or composition as a floor covering.

Mechanical Accessories of Rubber—Such common products as Fan Belts, Flexible Couplings, Radiator Hose and Insulation Tubing for wiring, point the way to ever increasing applications.

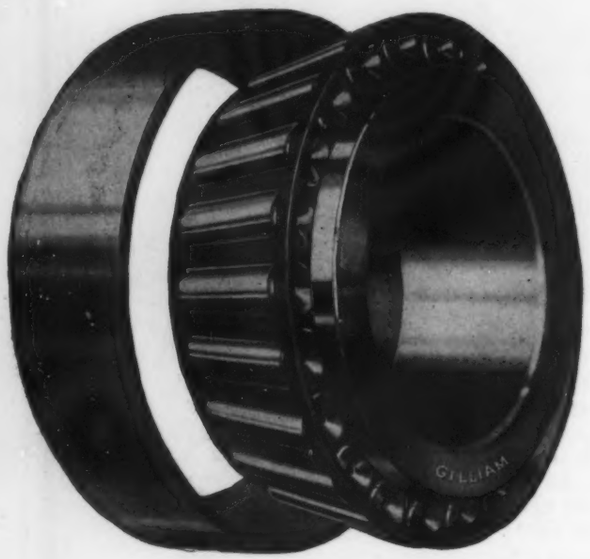
We invite Automotive Engineers to consider the applicability of *rubber* to their problems, and to take advantage of our experience in solving them.

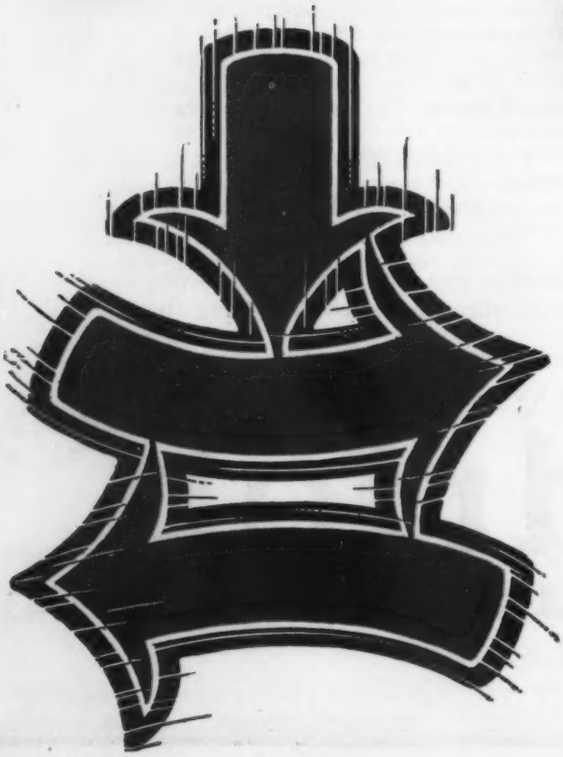
THE B. F. GOODRICH RUBBER COMPANY, *Akron, Ohio*
ESTABLISHED 1870

Goodrich
MECHANICAL RUBBER GOODS
"Best in the Long Run"

Bearing the load plus the "this way and that" forces!

Axle manufacturers using Gilliam Tapered Roller Bearings include: Adams, Clark, Columbia, Eaton, Flint, Salisbury, Standard Equipment, U S, Vulcan, Wisconsin.



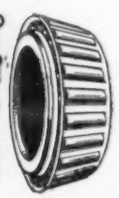


THE shock and strain of almost crushing loads speedily transported over rough roads and around sharp turns—impose a terrific burden on bearings—a burden under which improper design and faulty workmanship are bound to show up quickly.

As a move toward better Bearing performance and greater Bearing dependability—it will be advantageous to specify and use Gilliam Bearings, for you will find they have the capacity to meet all of the destroying forces.

THE GILLIAM MANUFACTURING CO.
CANTON, OHIO

GILLIAM TAPERED ROLLER Bearings



The arrow symbol signifies the recognized ability of Gilliam Tapered Roller Bearings to carry all combinations of radial and thrust loads from all directions. This better Bearing performance is due to the tapered roller principle, exclusive features of design and high grade alloy steel construction.

20-inch wheels

The first 20″ and 21″ steel wheels for balloon tires were Disteel wheels.

Disteel wheels and Tuarc wheels, both Motor Wheel Products, are today just as emphatically the first steel wheels for balloon tires

—In numbers used—in makes of cars using them—in the character of those cars—and in total miles of successful operation.

Motor Wheel pioneer experience with small-diameter wheels, as with all wheels, accounts for the great fund of authentic, specific information available to you through the factory, or through any Motor Wheel representative.

Ask *anything* about wheels for balloon tires of any type.

MOTOR WHEEL CORPORATION
Lansing, Michigan

Wood Wheels *Steel Wheels* *Stampings*

Disteel
Tuarc

Motor Wheel PRODUCTS

BAKELITE

TRADE MARK REG. U. S. PAT. OFF.

A Bakelite Switch "the heart of the system"

Built into the brake mechanism controlling the Packard automatic stop light is a molded Bakelite switch, which the Packard Motor Car Company has termed "the heart of the system."

This switch is proving to be of such sturdy character that no adjustments are necessary and the driver is assured of the proper operation of his stop light every time he needs it.

Study the sectional drawing of this Bakelite switch. Note the molded holes for the leads and binding posts—how the heavy brass terminals are solidly embedded. This was accomplished in a single operation.

There may be some part of your equipment that could be made better and more economically of Bakelite. Let our engineers serve you.

Send for our Booklet P.

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.
Chicago Office: 636 West 22nd Street

BAKELITE
Condensite
REDMANOL
are the registered Trade Marks for the Phenol Resin Products manufactured under patents owned by
BAKELITE CORPORATION

THE MATERIAL OF A THOUSAND USES

Guess vs Know

The human element enters into heating in the ordinary fuel-fired oven.

The Westinghouse Type K Oven provides exact, automatic control, eliminating guess-work.

Controlled Electric Heat

Controls Quality, Production, Wastage and Cost

There's a lot of "guess" involved when old-fashioned ovens are used for baking, drying, evaporating and other heat-treating processes. There is much time, labor, space and money lost; there is lack of uniformity in the product; the quality is not as good as it could be; the wastage is considerable.

But users of Westinghouse Type K Industrial Ovens have a different story to tell. This cabinet type oven, designed for many kinds of applications in the laboratory and shop, never fails.

It is fitted with removable angle-iron shelf racks, is scientifically ventilated, and automatically controlled. When installed it immediately introduces new standards of quality production.

This oven will more than pay its way. May we send you leaflet 1815 which gives complete details?

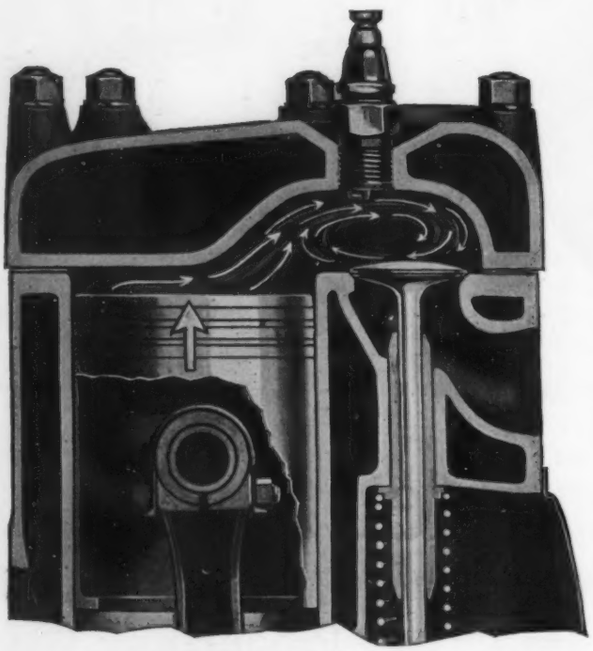
WESTINGHOUSE ELECTRIC & MANUFACTURING CO.
EAST PITTSBURGH, PA.
Sales Offices in All Principal Cities in the United States and Foreign Countries

It's a Problem Big Enough to Warrant Calling In a Westinghouse Heating Engineer.

Westinghouse

The Ricardo Head

The Importance of the Name in the Problem of Sales



United States Patent granted Nov. 13, 1923, to Waukesha Motor Company as assignee of Harry Ralph Ricardo, the English scientist.

IT would be difficult to obtain a more impressive measure of proof that the Ricardo Head is referred to as an engineering development that provides just the improvements that the car buyer wants than the unbelievably large volume of inquiries which follow the initial announcements.

At the National Automobile and Dealer Shows each succeeding display multiplied the number seeking opportunity for personal inspection.

From the Saturday Evening Post, the Literary Digest, the Class and Trade publications of the industry, reader response has been so great that we have been taxed in our endeavors to supply the information that is continually being requested.

The abundant power The Ricardo Head provides, the speeds it allows, the flexibility it gives and the economies it makes possible are qualities so distinctively desirable that there are few who have indicated they could afford to ignore them.

Likewise engine performance of such high character will contribute material sales assistance to the motor car producer who proclaims his good opinion of it by prominent display in his list of important specifications —the name Ricardo Head.

The Waukesha Motor Co.

Engine Builders

Waukesha, Wisconsin

NEW YORK DETROIT

STURDINESS
DURABILITY
CAPACITY

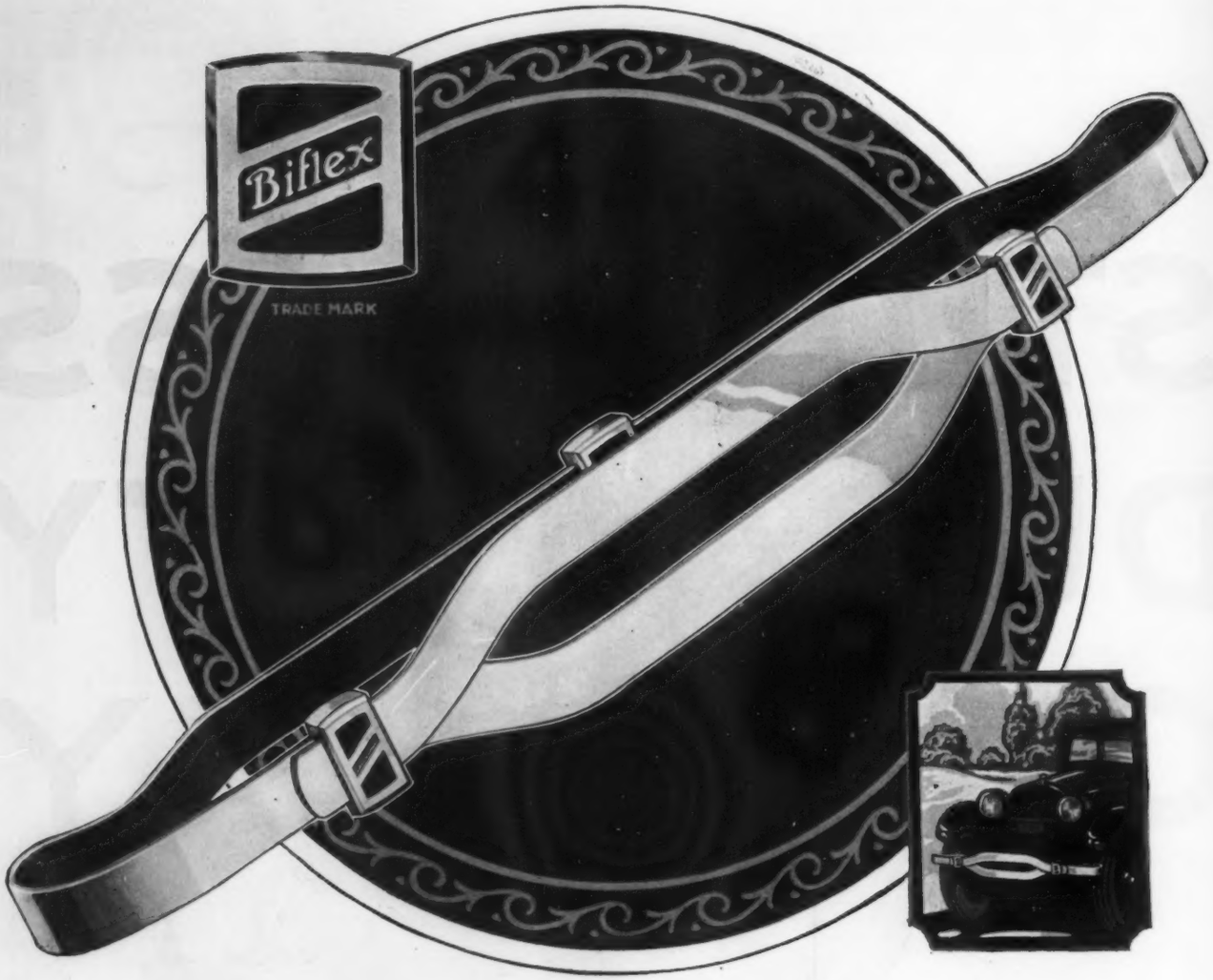
EVER since the first Hyatt Roller Bearing was manufactured 33 years ago, inherent sturdiness, durability and capacity have been conspicuous Hyatt qualities. And now these essential bearing qualities are provided to an even greater degree in the Hyatt New Series Roller Bearings.

HYATT ROLLER BEARING COMPANY

Newark Detroit Chicago San Francisco

Worcester Milwaukee Huntington, W. Va. Minneapolis Philadelphia
Cleveland Pittsburgh Buffalo Indianapolis

The New Series **HYATT** Quiet *Roller Bearings*



Biflex Conveys the Impression of Quality in Your Car

The world over, this fact is recognized: People and products are judged by the company they keep. A cheap bumper diminishes the prestige of the car on which it is attached. Biflex, on the other hand, adds to the car's prestige and emphasizes its quality.

The impression a bumper makes is always pronounced by reason of the conspicuous position the bumper occupies. Its prominence is a point in its favor with Biflex, for Biflex is worthy of the finest car — and the public knows it.

The quality of Biflex is impressed indelibly on the public mind. Its distinctive, pleasing appearance and its superior ability to protect have made it the world's standard of bumper value.

Steadily Biflex prestige grows. Day by day Biflex becomes a more and more important factor in the sale of motor cars of better quality.

Biflex aids dealers in closing sales.

THE BIFLEX CORPORATION, *Waukegan, Ill.*
Export Department: 130 West 42nd Street, New York City

Biflex
Cushion Bumper

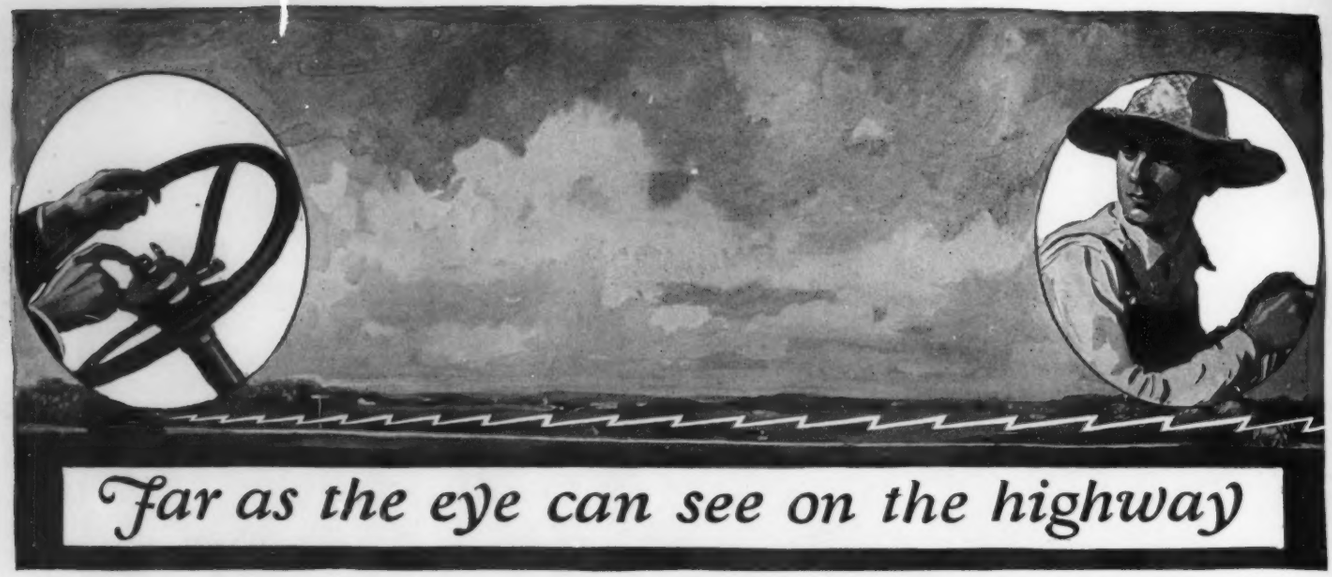
PROTECTION WITH DISTINCTION

Autocar

on all battery
equipped trucks
uses

WESTINGHOUSE
BATTERIES

WESTINGHOUSE UNION BATTERY CO.
Swissvale, Pa.



KLAXON'S Note "Carries On" —and Warns!

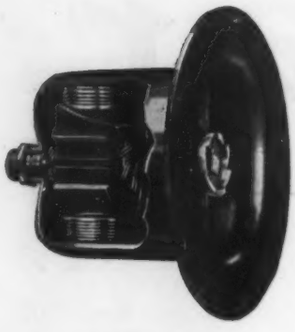
KLAXON warns in plenty of time! Its powerful, penetrating and unmistakable "saw-tooth" note *carries on*—far ahead of the speeding car!

Lumbering teams a half-mile ahead—drivers approaching on side roads—motorists coming toward you around dangerous curves—all these *hear* Klaxon in plenty of time to act.

The Klaxon note is the most penetrating sound ever invented. It cuts through fog, rain or snow. It sounds around corners and over hills. It rises above the noises of heavy traffic. It is *always* heard and *always* obeyed.

Klaxon is the most dependable horn you can buy. Since 1908, Klaxons have been built of the highest quality materials, accurately made and rigidly tested. Don't delay—stop at your dealer's and get *your* Klaxon today.

KLAXON *quality is safety insurance*



Complete Electric Motor

This cut-out view shows Klaxon's electric motor, encased in its weather-proof outer shell. Ball-bearing, self-lubricating, and made of the finest materials obtainable. The Klaxon Company originated the motor-driven horn—now recognized everywhere as the best—and its experience in this field eclipses that of any other manufacturer.

Actual vibrations which make up the Klaxon tone. The full even wave lengths explain Klaxon's full even note, and give visible proof of superior quality of the tone produced.

KLAXON

WORLD'S LARGEST PRODUCERS OF HORNS

"Oil-Vac"

A New and Better Principle

in Vacuum Fuel Feeding

DO YOU KNOW

What Happens at 55 M. P. H.?

Do you know that your motor requires 20 ounces of fuel per minute?

Do you know that it requires at least 4 inches of mercury suction to supply 20 ounces of fuel per minute?

Do you know that the suction from the intake manifold is less than 4 inches of mercury?

Do you know that with Oil-Vac the suction is more than 15 inches of mercury?

DO YOU KNOW

What Happens on a Hill at 20 M. P. H.?

Do you know that your motor requires 10 ounces of fuel per minute?

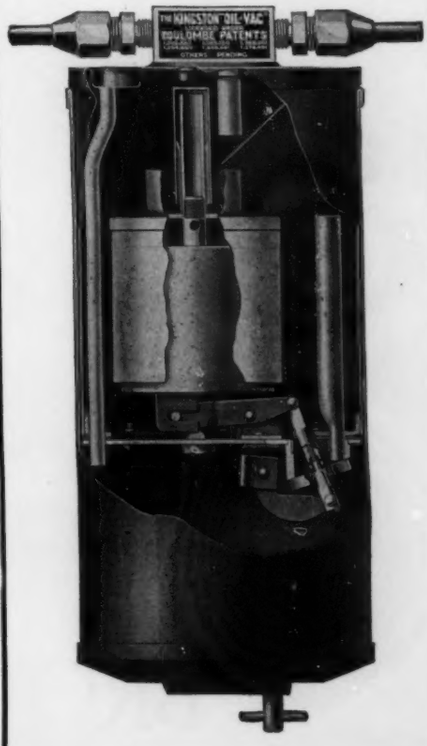
Do you know that it requires more than 3 inches of mercury suction to supply 10 ounces of fuel per minute?

Do you know that the intake manifold suction is less than 2 inches of mercury suction?

Do you know that with Oil-Vac the suction is more than 10 inches of mercury?

NO OIL—
NO VAC—
NO GAS

WITH OIL-VAC, the Kingston Vacuum Fuel Feeding System, the vacuum is produced by the circulating flow of oil, and increases with the increased speed of the motor. In other words, as the need for more fuel arises that need is supplied. This assurance of sustained power, on long grades, in rough going, and among the hills, will be appreciated by every motorist. The best qualities of Oil-Vac are most apparent in emergencies. With Oil-Vac the vacuum ceases when the oil supply becomes exhausted. No motor can operate, or should operate, without oil, so Oil-Vac, beside many other important features, contributes this valued factor of safety.

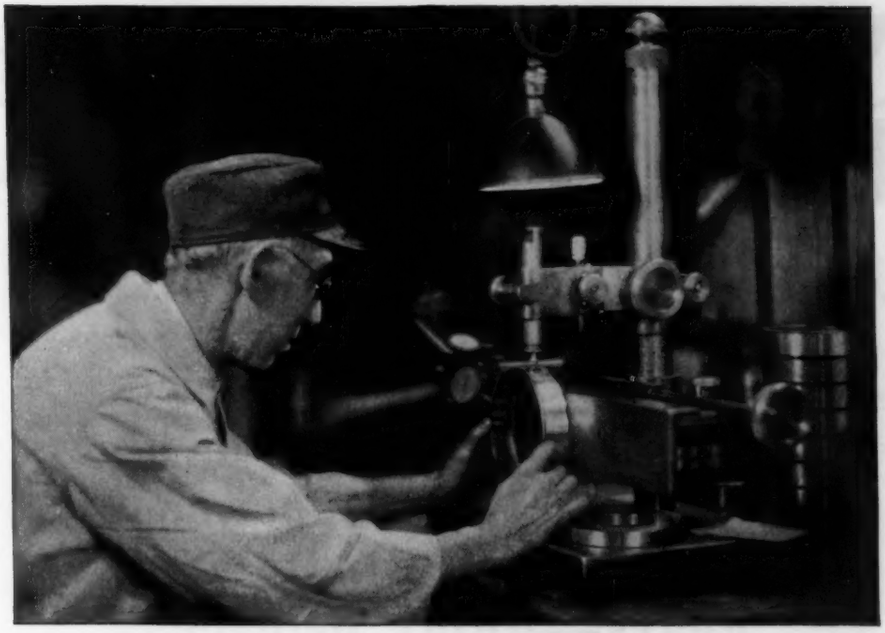


OIL-VAC SMOOTHS OUT THE HILLS

Dealers in cars using Oil-Vac as standard equipment should write for our Oil-Vac booklet. We have special information of great value to them.

BYRNE, KINGSTON & CO. KOKOMO, INDIANA, U. S. A.

MANY automobile manufacturers, well known to you—whose name-plates are an honor to American industry—have learned to depend upon Brown-Lipe-Chapin for their supply of quality differentials and bevel drive gears.
Manufactured at Syracuse, N.Y.
BROWN-LIPE-CHAPIN
DIFFERENTIALS—BEVEL DRIVE GEARS



One factory employe in eight is an expert inspector.

"Why should Strom Ball Bearings be specified for automotive installations?"

"Because Strom Ball Bearings will carry the greatest load with the least friction in limited space on the shaft, and because of their reliability, quietness and smoothness of operation."

This was the answer we made to a motor car manufacturer when he asked the foregoing question.

Strom Ball Bearings are made of chrome steel. Machined with the scientific precision of the *finest* watch parts. Tested through every step in manufacturing by expert inspectors.

Once installed Strom Ball Bearings give real wear and satisfaction. They are heat-treated through and through, not merely case-hardened.

Strom Ball Bearings have been standard equipment for years on the highest priced motor car and quality motor truck built in America. Proof of reliability, because selected only after the most scrupulously careful tests.

If you have problems of power transmission, let us help you solve them.

Double-acting thrust bearing, flat seats (grooved races) 2100-F Series

Single-acting thrust bearing, flat seats (grooved races) 1100-F Series

Single-acting, self-aligning thrust bearing 1100 Series

Single-acting, self-aligning thrust bearing, leveling washer. 1100-U Series

Double-acting, self-aligning thrust bearing, leveling washers 2100-U Series

Single-row deep-groove Standard type, radial bearing

Double-row, deep-groove Standard type, radial bearing

Angular contact bearing, combination radial and thrust

Double-row, maximum type, radial bearing

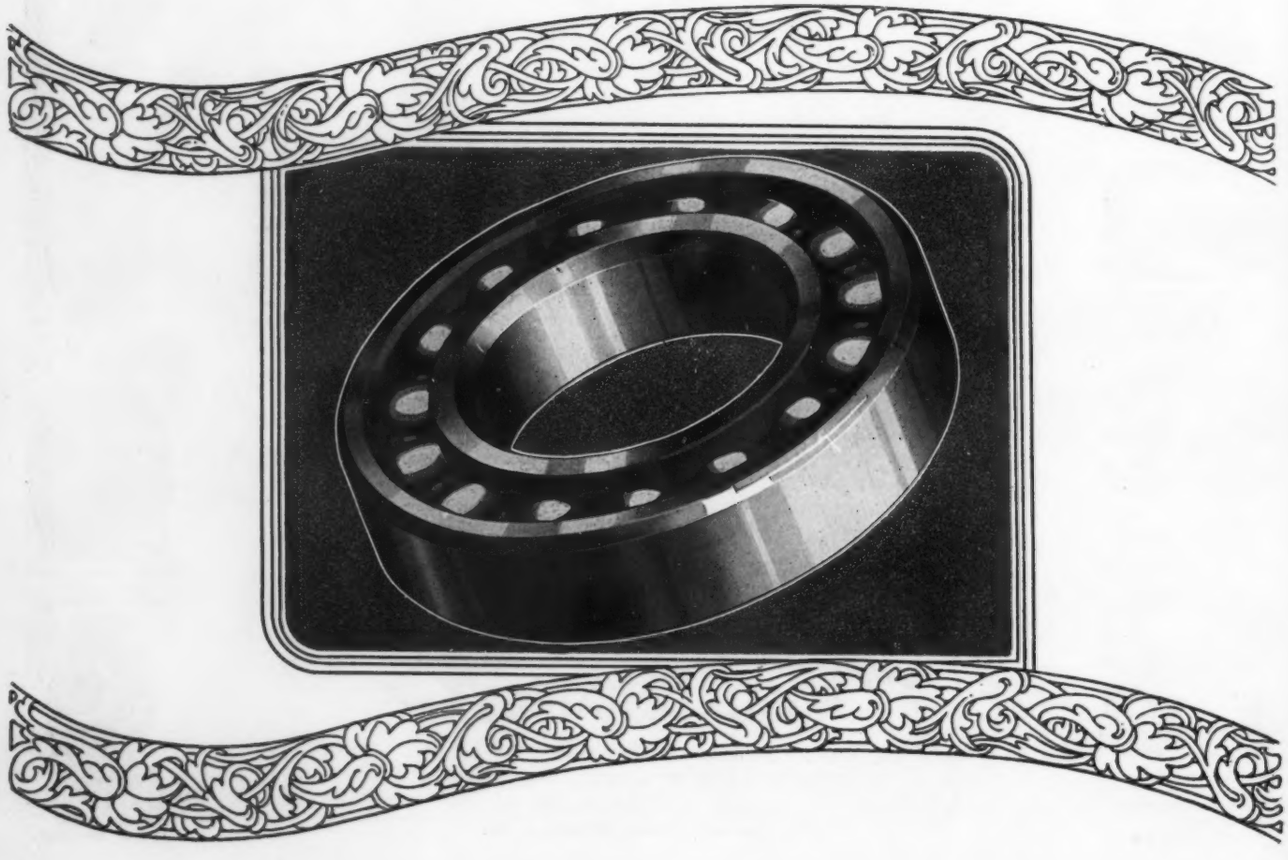
Single-row, maximum type, radial bearing

Strom BALL BEARINGS

Manufactured by
STROM BALL BEARING MFG. CO.
Formerly U. S. Ball Bearing Mfg. Co.
4533 Palmer Street, Chicago, Ill.

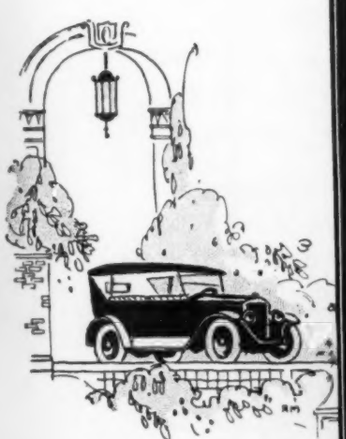
New Departure Ball Bearings

are precisely made friction eliminators which positively and permanently locate shafts and gears—delay depreciation; reduce upkeep expense; simplify lubrication.



MORSE
GENUINE SILENT CHAINS

Simplicity of application—proper functioning under all conditions, silent operation at all speeds — are the three things which have made Morse Genuine Silent Chains favorites with the majority of automobile engineers. Each Morse installation is an individually engineered job — our experience combined with years to develop the greatest simplicity and economy of power for your engine.



Morse Chain Standard Installations

Anderson Six
Auburn Six
Barley Six
Cadillac Eight
Case Six
Chalmers Six
Chandler Six
Chrysler Six
Cleveland Six
Columbia Six
Crawford Six
Davis Six
Eagle Four
Essex Six
Flint Six
Fox Six
Hupmobile Four
Hudson Six
Jordan Six
Lafayette Eight
Lincoln Eight
Moon Light Six
National Six
Northway Four
Oakland Six
Packard Six
Packard Eight
Peerless Six
Rickenbacker Six
Stearns Four
Stearns Six
Sterling-Knight Six
Studebaker Light Six
Star Four
Templar Four
Winton Six
Continental Motors

MORSE CHAIN COMPANY

Main Office and Works
ITHACA, NEW YORK

Sales and Engineering Office
DETROIT, MICHIGAN

Thousands of Manufacturers have found that they pay less and get more when they buy

BUNTING
BUSHING BEARINGS
PATENTED

¶ **SPECIAL SIZES** and alloys made to your specifications.
¶ **STANDARD SIZES** out of Bunting's great stocks of "Ready Made" Bushing Bearings.

BUY them either way and you will find that a Bunting Bushing Bearing costs you less than any you can make or finish in your own shop.

It's because Bunting brings to the work the efficiency of a great organization and factory working in large volume on bronze bushing bearings exclusively.

Specialized methods and equipment keep costs far below anything obtainable in an operation less extensive and less experienced. Bunting quality is the universally accepted standard.

If you want to know how much you can be saving on your special order bushing bearings send in your blue prints.

If you want to buy your finished bushing bearings out of stock at long run prices for small lots write for Stock List L showing 269 sizes always ready to ship.

THE BUNTING BRASS & BRONZE CO.
TOLEDO, OHIO

Branches and Warehouses at

NEW YORK	CLEVELAND	CHICAGO	PHILADELPHIA	SAN FRANCISCO	BOSTON
245 West 54th St.	710 St. Clair Ave., N. E.	722 S. Michigan Ave.	1330 Arch St.	198 Second St.	36 Oliver St.
Circle 0844	Main 5991	Wabash 9153	Spruce 5296	Douglas 6245	Main 8488

All plant processes under constant laboratory control.

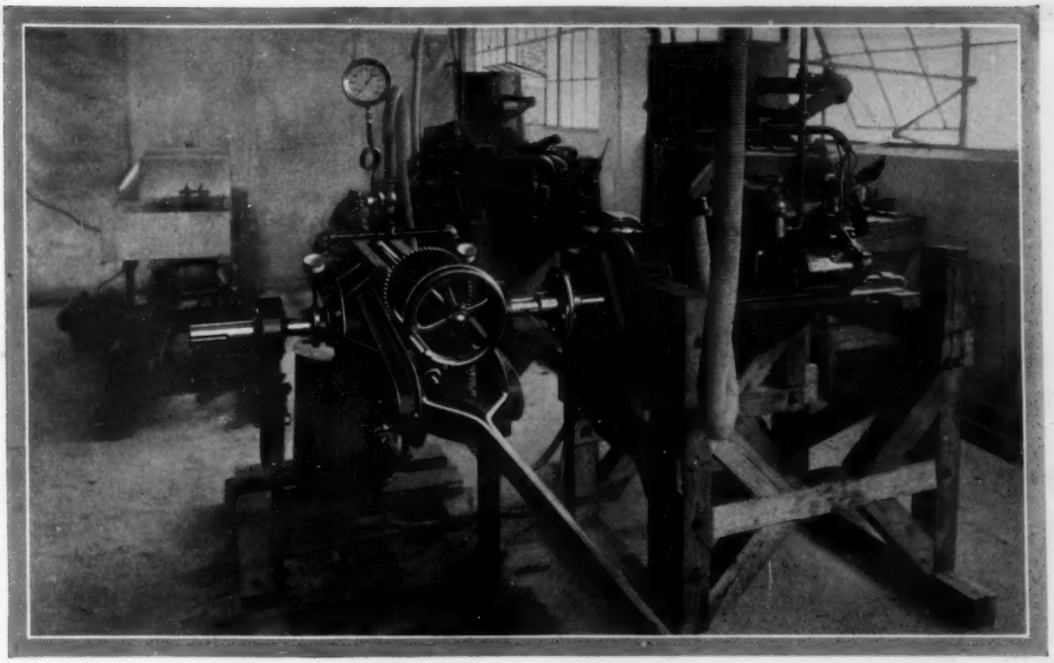
One of the finest bronze foundries in the world.

A great modern plant specializing intensively in one product.

BUNTING
BRONZE BAR
Shop Assortment

5 bars of genuine Bunting Phosphor Bronze in a strong box meets every usual shop need for high quality bearing metal – at all leading mill supply jobbers. 50 other sizes always in stock.

The more you make, the more you lose.
—Baby Bunting



Pioneering Work in Timing Drive

LABORATORY work on timing drive in the Formica plant during the past few months has developed important information on the subject which every engineer who contemplates changing the front end of his motor should have.

The causes of troubles that have been occasionally experienced with non-metallic gears have been located. An additional process has been added to Formica production which strikes at the root of the rare cases of erratic expansion experienced by engineers with this material.

Motor conditions developed by factors that have nothing to do with timing drive, have been shown to exert an important influence on gear performance. This material is now in such shape that the most valuable assistance is available to engineers in perfecting a trouble-proof, durable and entirely satisfactory drive.

The Formica laboratories stand ready to make a special study of specific engines. This service may be had by any engineer for the asking. Write the Formica laboratories today.

THE FORMICA INSULATION COMPANY

4648 Spring Grove Avenue, Cincinnati, Ohio

FORMICA

Made from Anhydrous Bakelite Resins

SHEETS TUBES RODS

An Opinion From the Builders of One of the World's Finest Cars

THE builders of one of the world's finest cars, whose policy, unfortunately, prevents the mention of the company name in advertising other than its own, was recently asked whether they used Vanadium Steel and why.

The answer is interesting—and deeply significant to all who are trying to build a better car or make a higher grade part:

"Chrome-Vanadium Steel is used in important forgings such as front axles, steering knuckles, steering knuckle levers, axle shafts, and in fact all forgings requiring high strength with good ducility.

"We have made many tests to show the improvements of Vanadium Steel over other steels of about the same cost.

"The fact that Chrome-Vanadium Steel gives higher and more uniform physical properties than other types of alloy steel at about the same price is the quality which makes it a particularly good value."

There is little we can add, or would care to add, to this summing up of Vanadium advantages by a manufacturer whose reputation is world-wide.

May we, however, offer the assistance of our metallurgists in helping you to select a better steel for your particular purpose?

VANADIUM CORPORATION OF AMERICA

NEW YORK
120 Broadway

DETROIT
Book Bldg.

VANADIUM STEELS

for Strength, Toughness and Durability

The wetter we became the madder we got—

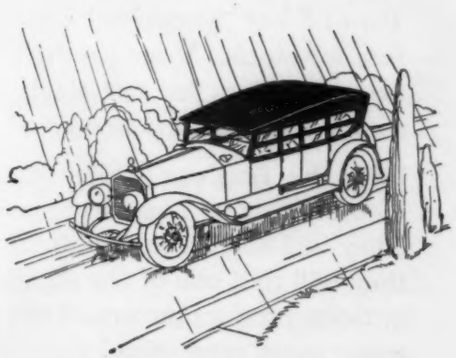
"After all they'd told us about how dry and 'cozy'—how I hate that word—the top would keep us, to have it act like a sieve!"

* * *

MANY a car manufacturer's reputation suffered because the top, bought as an accessory, like a spare tire or a spotlight, fell down miserably. But, on the other hand, others added to their customer-regard by standardizing on tops of Neverleek. It was the first top material to be truly weather-proof under all conditions—and guaranteed to be.

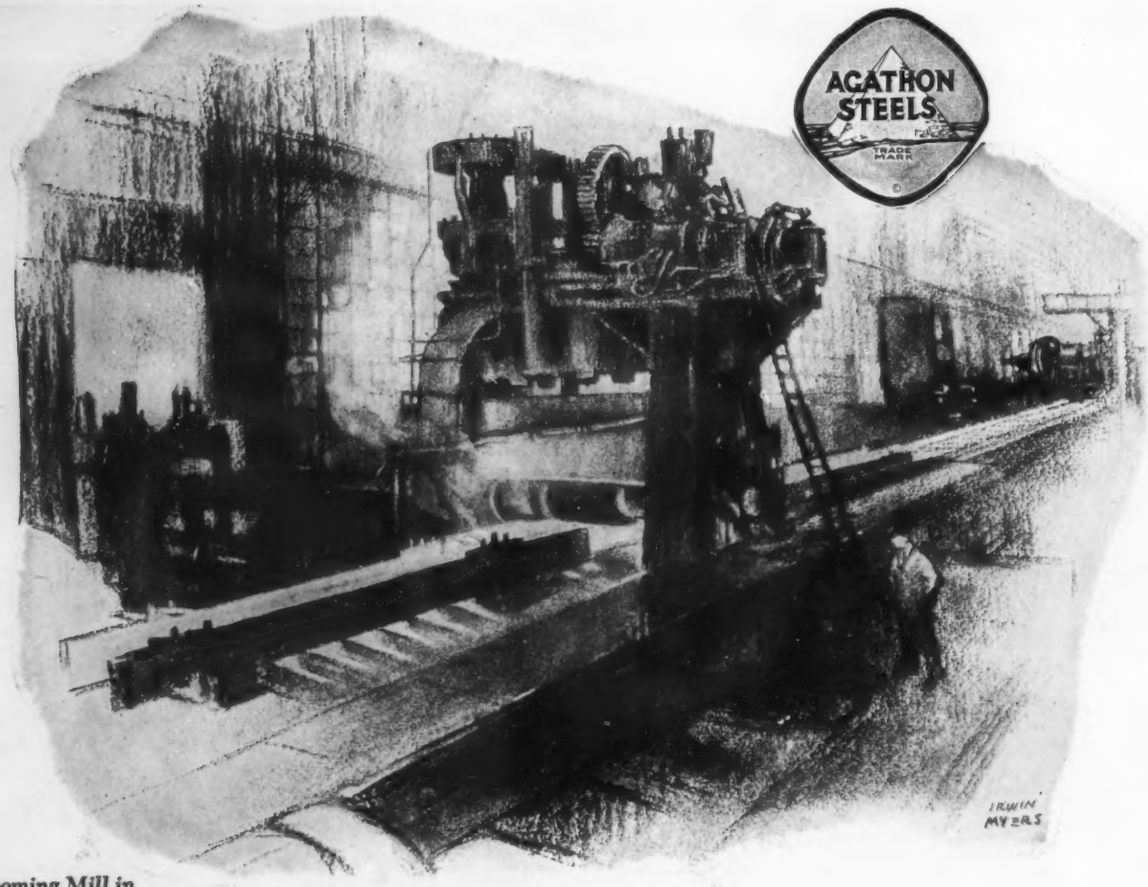
Now, when appearance is vital and the beauty of body lines can be made or ruined by the top, manufacturers in increasing numbers entrust their reputations for smartness and style to tops of Neverleek. It tailors perfectly, meeting every requirement in cutting, fitting and trimming. And through years of use it keeps its beautiful lustre undimmed by extremes of weather.

Samples of Neverleek, in a variety of grains and linings, with prices, will be sent on request to manufacturers of automobiles, tops and bodies.



NEVERLEEK
TOP MATERIAL
Trade-mark Reg. U. S. Pat. Off.

F. S. CARR COMPANY, 31 Beach Street, Boston, Mass. *Branches:* Detroit, St. Louis, Atlanta



Blooming Mill in Central Steel Co. Plant

Would an Alloy Steel Benefit Your Product?

OFTEN you have wondered if it wouldn't. And just as often you have set the problem aside to investigate *sometime*. That "sometime" has never arrived. You are still using inferior steels. Your product still suffers. Because you may be paying less for the steel you are using, you feel you are saving money. *But are you?*

Why not find out? Why not put your problem up to our metallurgists? They have solved such problems for many. They will solve yours without charge or obligation. Perhaps they will find one of the Agathon Alloy Steels which we have in daily production would not only benefit your product but prove more economical than the steel you are using. Maybe your requirements call for a special analysis of steel. Our metallurgists will tell you frankly and impartially.

We have a daily production in all kinds of Agathon Alloy Steels such as—

Nickel, Chrome-Nickel, Uma, Molybdenum, Chrome-Molybdenum, Nickel-Molybdenum, Vanadium, Chrome-Vanadium, Chromium, etc.

Deliveries in Blooms, Billets, Slabs, Bars, Hot Rolled Strips, etc.

THE CENTRAL STEEL COMPANY, Massillon, Ohio

SWETLAND BLDG. CLEVELAND | BOOK BLDG. DETROIT | PEOPLES GAS BLDG. CHICAGO | UNIVERSITY BLOCK SYRACUSE | WIDENER BLDG. PHILADELPHIA

AGATHON ALLOY STEELS

Achievement!

The DOT •

TRADE MARK

NATIONAL RECOGNITION

The DOT has won the approval of engineers, mechanics, manufacturers and users. Tested and adopted by U. S. War Department — adopted by 70 manufacturers of cars, trucks and tractors — used in more than 100 leading industries in America.

NATIONAL DISTRIBUTION

Leading jobbers and distributors located in the centers of all the trading areas are establishing DOT Sales, Service and Supplies among their thousands of dealers everywhere. DOT owners are assured easily available service and supplies.

High Pressure Lubricator

The reason why motorists, manufacturers and engineers are so enthusiastic in their endorsement of the DOT is the fact that actual demonstration and tests have proved that no other system gives *thorough* lubrication with such ease, speed and cleanliness.

No matter how stubborn the bearings, there is no need to go to the service stations or use compressor tanks when with one hand alone the operator can develop the tremendous pressure of 3000 pounds or more with the DOT. In 13 minutes or less the motorist can lubricate his entire chassis without even soiling his hands.

May we demonstrate the many exclusive features of the DOT and show you how the DOT wins owner satisfaction and dealer enthusiasm for the 70 manufacturers who have already adopted it?

Made only by

Carr Fastener Co., 31-37 Ames St., Cambridge, Mass.

"Originators and Makers of the DOT line of fasteners"

Branches

40 Selden Ave., Detroit — Gage Ave. & Beach Rd., Hamilton, Ont., Can.
Monadnock Bldg., San Francisco — 47 W. 34th St., New York City

What Manufacturers and Engineers Say

"Our experience with the DOT system on our gasoline taxicabs has been so satisfactory that we are more than pleased to make it standard on our electric cars as well."

Rauch and Lang, Inc.
Chicopee Falls, Mass.

"We estimate that the DOT is saving us more than $3,000.00 per year in time and replacements."

Westcott Express Co.
New York City

"In our opinion the best pressure lubricator on the market is the DOT. We have installed this system on our service trucks."

Ratterman Motor Service Co.
Cincinnati, Ohio

"Before installing the DOT it took an hour and a half to grease a car. Now the same operation takes only 15 minutes and the bearings are more thoroughly lubricated."

Norton Co.
Worcester, Mass.

"Because we think very highly of the DOT lubricating system, we specify it as standard equipment on all our cars."

Haynes Automobile Co.
Kokoma, Ind.

Dot Distributors

The Dot Lubricator Co. of New England
739 Boylston St., Boston

Fink-Dumont-White, Inc.
405 Lexington Ave., New York

Downing Brothers
2 West Preston St., Baltimore

The J. V. Walsh Company
1101 Peoples Bank Bldg.
Pittsburgh, Pa.

Philadelphia Body & Truck Equip. Co., 2123 Vine St.
Philadelphia, Pa.

Walraven Company (industrial)
38 West Alabama St.
Atlanta, Ga.

Motor Parts Corporation
353 Ivy St. Atlanta, Ga.

Burgamy Auto Parts Co.
804 Sycamore St., Cincinnati

Motor Rim Manufacturers Co.
1835 East 24th St., Cleveland

The Alden Perrin Co.
538 South Clark St., Chicago

Burd Ring Sales Company
725 Pine St., Seattle, Wash.

M. H. Rykoski
706 Julia St., New Orleans

Indiana Wheel & Rim Co.
40 W. North St.
Indianapolis, Ind.

Peerless Rubber Products Co.
713 Jefferson Ave.
Toledo, Ohio

The Walraven Company
212 Kinney Bldg.
Charlotte, N. C.

The DOT Lubricator is Thoroughly Protected by Allowed Claims of Pending Patent Applications.

This shows the large number of discs used in making a molded Celoron gear blank

This is the finished gear blank of Celoron, bonded at high temperature under high pressure

The secret of silent timing

Resilient, non-metallic gears of Celoron rid the timing gear case of noise

FROM coast to coast, repairmen and service stations are banishing timing gear noise with Celoron Silent Timing Gears. Manufacturers of many popular makes of cars now use these gears as standard equipment.

What makes timing gears noisy

The harsh metallic hum that comes from many timing gear cases is the result of metal to metal contact and wear on the metal gear teeth. The play of worn metal teeth causes a rapid succession of metallic blows that produce the familiar roar so irritating to drivers' nerves.

How gears are silenced

Celoron Silent Timing Gears do away with the contact of metal on metal. They reduce wear, absorb vibration cushion shocks. In operation, gears of Celoron are positive, accurate, and silent at all motor speeds. Celoron Silent Timing Gears are tough and durable. They are impervious to oil, grease, and water. They do not swell, even in the hot oil of the timing gear case.

Celoron is stabilized

Celoron is a laminated phenolic condensation material bonded with bakelite. Gear blanks are either molded to dimension or cut from sheet stock.

Celoron is made into silent timing gears for the replacement trade by Dalton and Balch. Jobbers and dealers all over the country carry stocks of these gears.

Look for the "D & B" and "Celoron" marks.

They insure your getting a genuine Celoron Silent Timing Gear for your car.

SILENCING MACHINE GEAR DRIVES

For every direct drive used in factories there is a Celoron Silent Gear. These gears drive big punch presses, pumps, and cranes. On all the rugged and delicate production machines Celeron Silent Gears work effectively and silently. They are cut from Celeron, a laminated phenolic condensation material, bonded with bakelite.

CELORON SILENT GEARS

DIAMOND STATE FIBRE COMPANY

BRIDGEPORT, PENNSYLVANIA

Branches in Principal Cities Toronto, Canada—London, England

Make Celoron Silent Timing Gears standard equipment on all your future cars

Photograph of Mr. Leiper's Cadillac taken at a gate of the walled City of Tungchow, China

Thousands of Miles over the Ancient Roads of China

Between Pekin and Tientsin stretch 83 miles of typical Chinese highways—roads so rutted and difficult that the average driver in this country would think twice before even attempting to enter them.

Yet Mr. H. H. Leiper of the American Board Mission has driven his Delco-equipped Cadillac for many thousands of miles over these and other just such types of Chinese roads, toiling back and forth on famine relief errands of mercy.

Even under these aggravated road hardships, the Delco-electrical equipment of his car gave faultless performance.

This record is simply another example of the extraordinary service which causes Delco—the world's foremost Starting, Lighting and Ignition system—to be the choice of nearly all builders of quality motor cars.

THE DAYTON ENGINEERING LABORATORIES COMPANY
DAYTON, OHIO, U. S. A.

Delco

STARTING, LIGHTING AND IGNITION

DIXON'S 677

FOR TRANSMISSIONS AND DIFFERENTIALS

Two or more competing cars may be so nearly equal that long arguments fail to reveal any decisive difference.

Proper lubrication will reveal and prove the difference because it will make a car out-serve and out-wear its competitor by a very wide margin.

Dixon's 677 will meet fully the most exacting specifications and requirements for gear box lubrication.

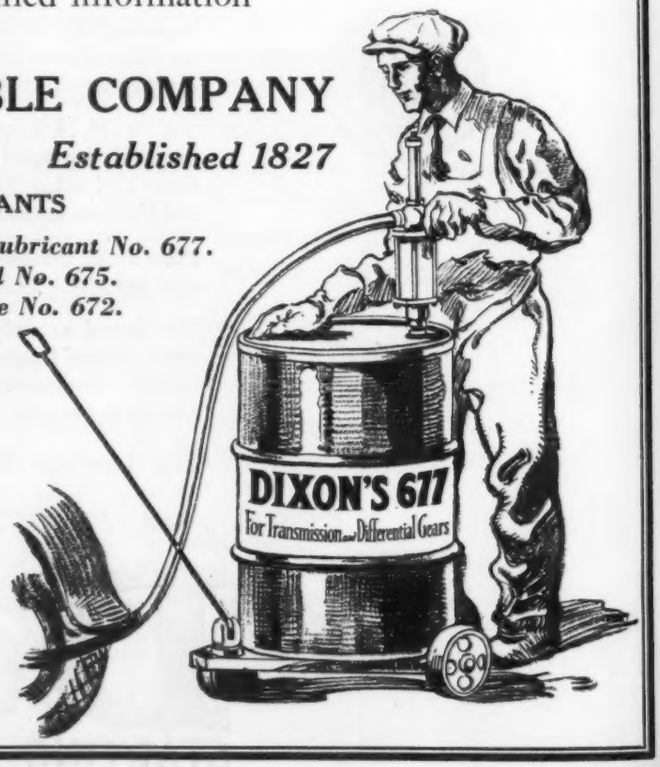
Write for more detailed information

JOSEPH DIXON CRUCIBLE COMPANY

Jersey City, N.J., U.S.A. D X N *Established 1827*

MAKERS OF QUALITY LUBRICANTS

For Spur and Bevel Gears Use Dixon's Gear Lubricant No. 677.
For Worm Drives Use Dixon's Gear Oil No. 675.
For Universal Joints Use Dixon's Grease No. 672.

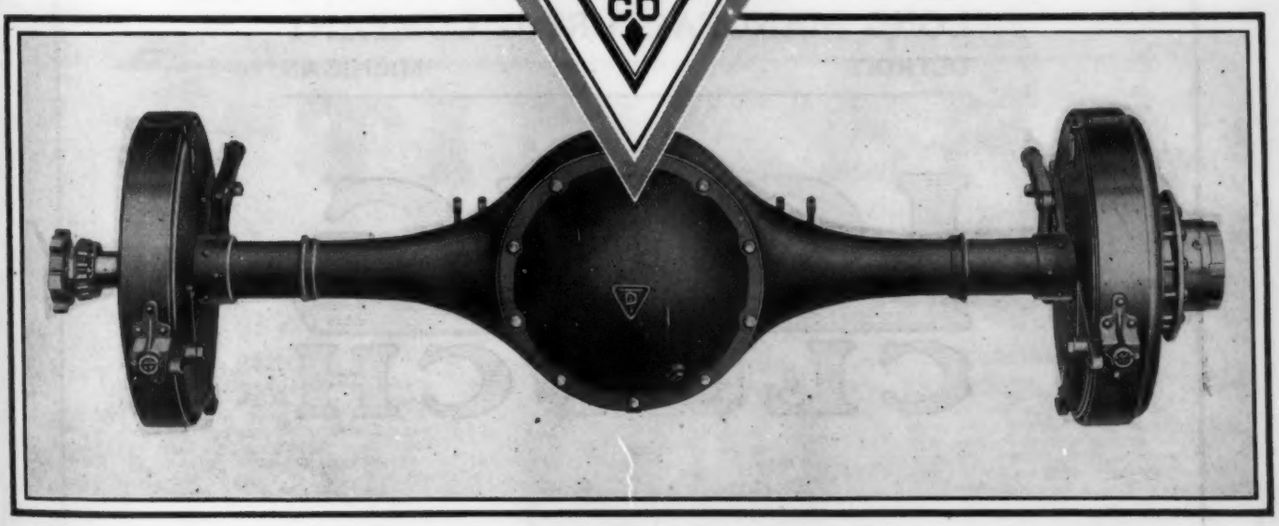


TIMKEN

Most rear axles nowadays are out of sight—hidden by gas tank and spare tire.

But good rear axle designing and building is as important as ever and Timken reputation is known to every car owner.

THE TIMKEN-DETROIT
AXLE COMPANY
Detroit, Mich.



AXLES

A Commendable Reputation

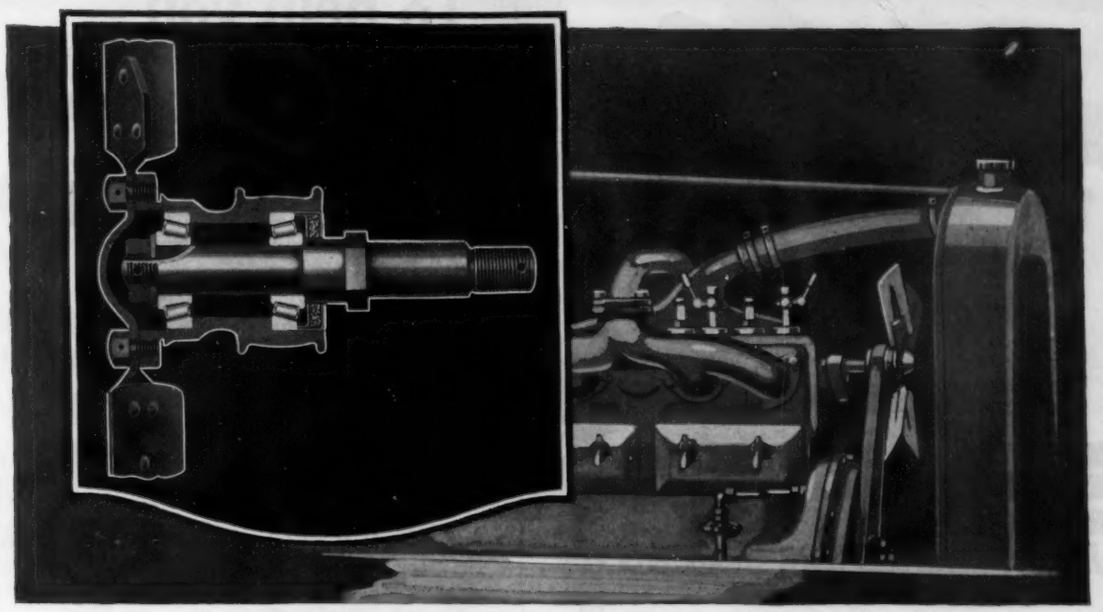
The Long Clutch, since its advent, has proven its worth to both manufacturer and driver of the motor car.

Its performance has been such that it has brought constant, increasing praise from maker and user.

LONG MANUFACTURING COMPANY
DETROIT - - - - MICHIGAN

LONG CLUTCH

LONG PRODUCTS — RADIATORS AND CLUTCHES



137,760,000 Revolutions—.002 Total Wear Divided Between Two Bearings

"An 18" fan properly housed, belted to an electric motor, was driven 2050 R. P. M. continuously for 137,760,000 revolutions, equalling in car mileage 45,000 miles. The bearings were then removed and examined. There was .0015 wear on the forward bearing—.0005 wear on the rear bearing — a total of .002; in fact, not sufficient wear to require adjustment—the grinding marks were not even worn off the cup, cone or roll surfaces. The wear was determined by measuring the distance from the front face of cone to the back face of cup before and after tests. Before beginning the tests, hubs were packed with grease and no further lubricant was required."

This test should tell an interesting story to any automotive engineer who is working toward an improved fan mounting. We will be glad to send blue prints and supply additional information.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

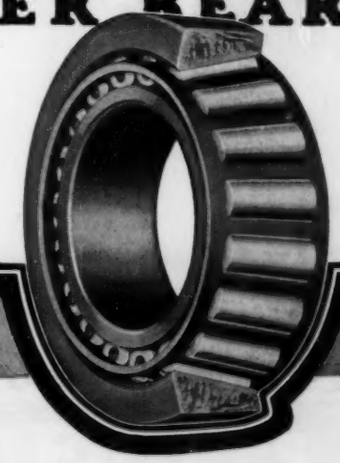
TIMKEN

Tapered

ROLLER BEARINGS

PRINCIPLE

The Timken dual duty capacity to take, in one bearing, both radial loads and thrust loads, makes Timken Tapered Roller Bearings particularly desirable at front wheels, steering pivots and worm, transmission, pinion, differential and rear wheels. They save repair bills.



PERFORMANCE

For twenty-five years, engineers have approved Timken durability, economy and trouble-free performance. One hundred million Timken Bearings have been manufactured. Only the Timken basic principle plus Timken cooperation has made this performance possible.

© 1924, T. R. B. Co.

SHAFER
Self-Aligning ROLLER BEARING
PAT. & PATS.PENDING
SHAFER Roller Bearings combine the rotating freedom of ball bearings with the maximum load capacities of Roller Bearings, carrying all combinations of thrust and radial loads. They are also self-aligning.
Furnished in Interchangeable Sizes
SHAFER BEARING CORPORATION
6501 WEST GRAND AVENUE
CHICAGO, ILL.

To help you select the proper truck tire equipment

There is a Kelly-Springfield truck tire for every weight of truck and every type of service.

To help Automotive Engineers and Purchasing Agents to determine the size and type of tires best suited to their requirements, our Engineering Service Department has prepared a booklet, "Specifications of Kelly-Springfield Truck Tires," showing comparative cross-sections of all our various types of tires and giving detailed information as to the carrying capacity and principal advantages of each.

We will gladly send a copy of this booklet to any one who is interested.

Address inquiries to

Engineering Service Department

Kelly-Springfield Tire Company

250 West 57th Street, New York

Consult Mueller for Brass

For 65 years Mueller has specialized in brass castings—delivering quality, quantity and price.

When your costs must be reduced or quality bettered, investigate

MUELLER

Sandcraft Brass Castings

—machined when so desired

Mueller Manufactures:

Red Tip Brass Rod
Relleum Brass Forgings
Niag Nickel Silver Rod
Sandcraft Brass Castings
Brass Screw Machine Parts
Blue Tip Tobin Bronze Rod
Brass and Copper Seamless Tubing
Mueller Tobin Bronze Welding Rod

All heats are subject to strict laboratory control—the foundry equipment is modern—and the Mueller brass-crafters are unrivalled.

Your inquiry, with sample or drawing, will allow us to prove that it pays to put your brass requirements up to Mueller.

Mueller, Port Huron, Michigan
Associated with Mueller Co., Decatur, Ill., and Sarnia, Ont.

Mueller Forges Brass!!

The Universal Push Button

PERFECT CONTACT IS SECURED ON ANY ANGLE

More Than Two Million in Use

The General Phonograph Mfg. Co.

(Formerly named The Garford Mfg. Co.)

ELYRIA, OHIO

Battin' 'em out

—no matter how hard or fast the orders come at us, we're knocking them out of the lot. Pitch one at our

Foundry Department

and find what our "home run" service on Aluminum, Manganese, Phosphor Bronze or any other Non-Ferrous Metal Castings means to you, in running up your profit score.

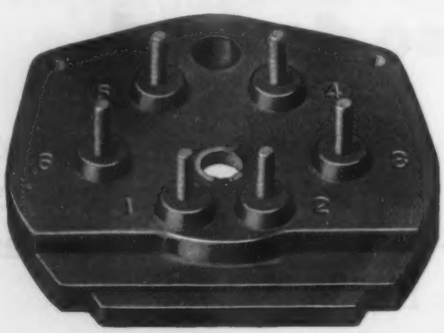
Our Motor & Transmission Dept.

makes gears, transmission parts, etc., right—it's a habit acquired when building our L. M. F. Motors.

The Helpful L.M.F. Book, FREE

Send us your samples or blue prints for estimate.

LIGHT MFG. & FOUNDRY CO. POTTSTOWN, PA. U.S.A.

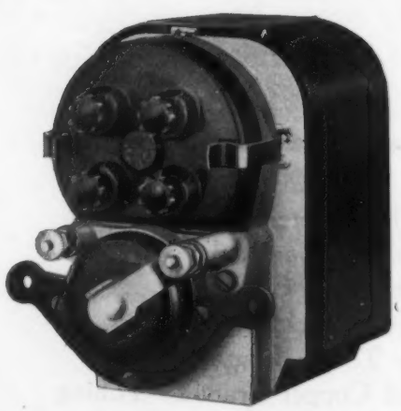


The new plant of the International Insulating Corporation, now located at Elyria, Ohio, has been completed and is in production on gear shift lever balls, distributor heads, radiator caps, electrical connections, and all moulded parts, either from shellac composition or synthetic material, used on automobiles.

INTERNATIONAL INSULATING CORPORATION

ELYRIA - - OHIO

TEAGLE



SIMPLICITY-RUGGEDNESS
EFFICIENCY-RELIABILITY

Conforms to S. A. E. Standards

Write for Further Information

The Teagle Co.

Cleveland, Ohio

"The Simplest Magneto of Them All"

POSITIONS WANTED

By

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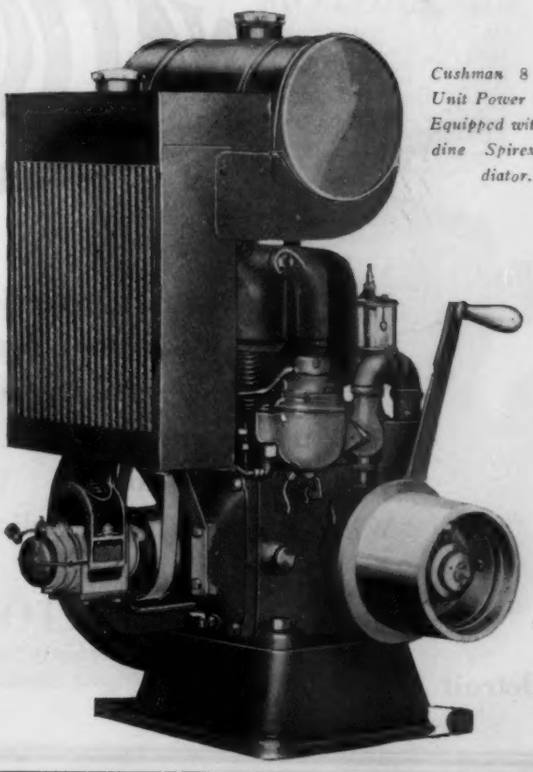
Modine Manufacturing Co.
Racine, Wisconsin



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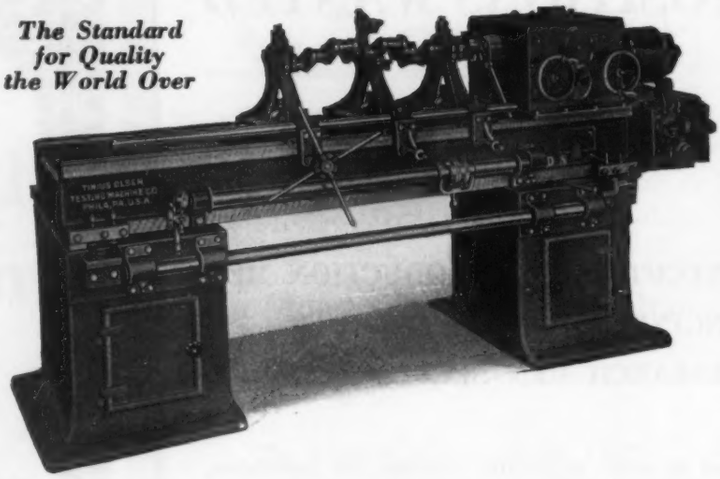

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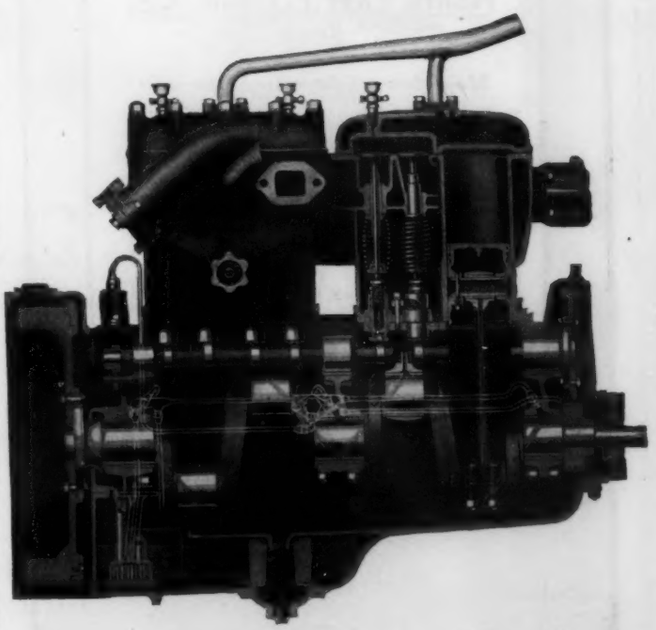

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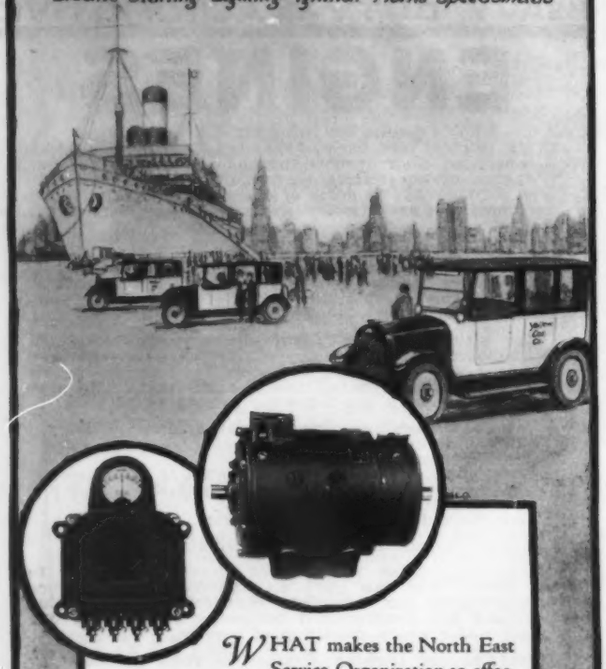

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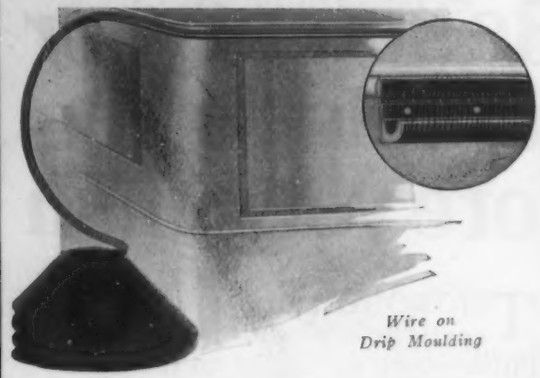

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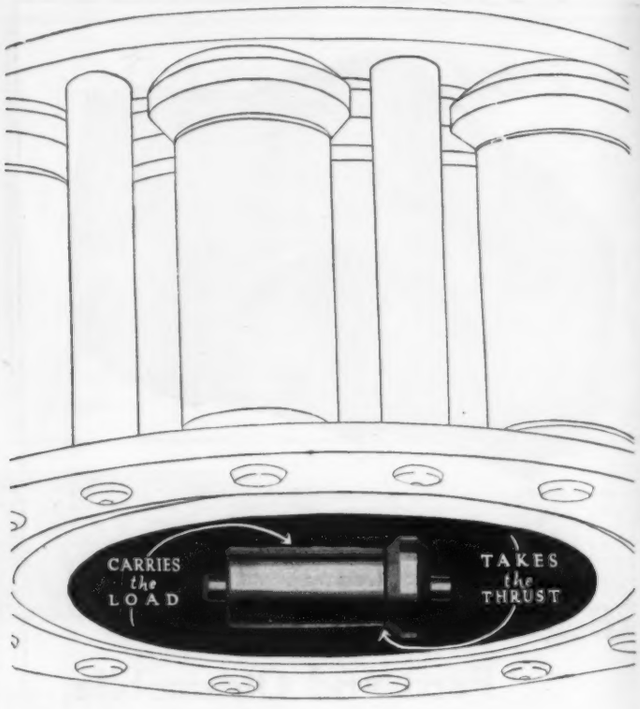

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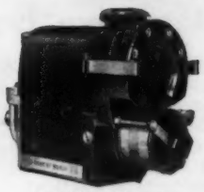

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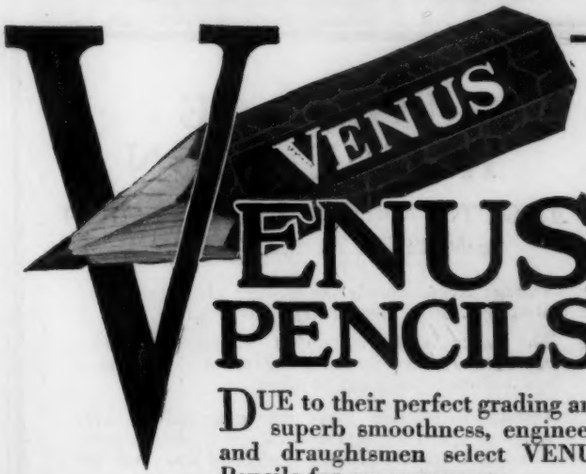

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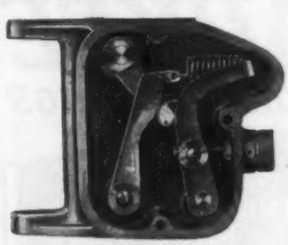

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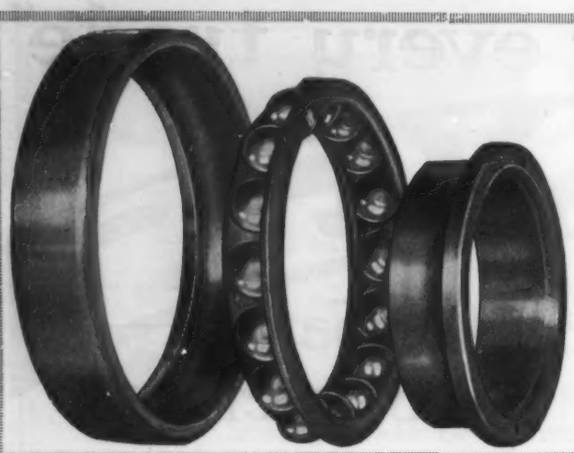

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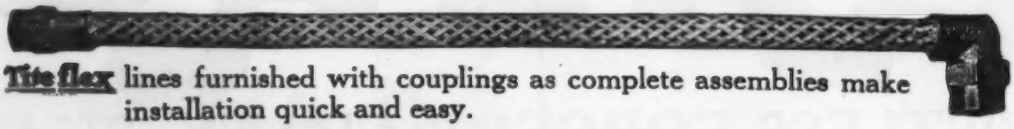

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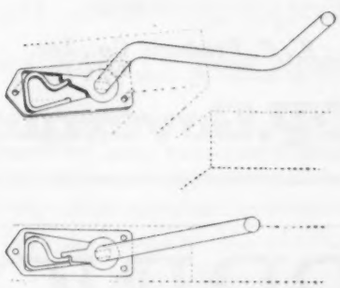

Showing position of rod, door open and when closed against body curtain

This newly patented door curtain opener is the long wanted improvement in these devices.

It gives a *spring tension* overlap of the door curtain on the body curtain, thereby guaranteeing a weather tight job.

Simple, strong, easily attached, any rod fits any door. Reasonably priced and absolutely the final answer for satisfactory curtains. Just the thing for your next model.

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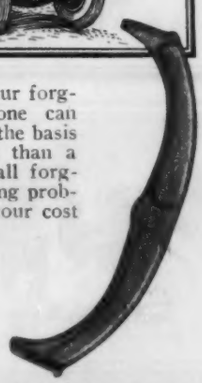

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The Heat Is There—
Why Not Use It?

PERFECTION MOTOR CAR HEATERS

The Perfection Heater & Mfg. Co.
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DEPENDABLE

In the operation of a complete and modern Felt Cutting Plant at Detroit, as well as four Felt Mills, the American Felt Company has provided the Automotive Industry with an entirely dependable source of supply. Quality, uniformity and quantity are under complete control from the raw wool to the automobile.

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Spring Clips
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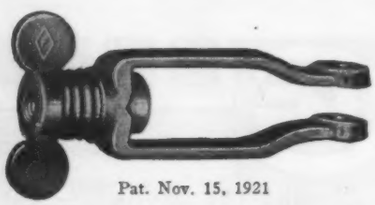

Pat. Nov. 15, 1921

"the keystone of equalized brake adjustment."

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K.P. is simple and automatic—no complicated parts—durable and efficient.

It positively governs—but *does not* restrict engine power.

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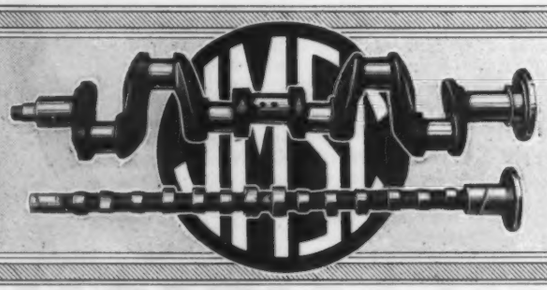
GOVERNS WITHOUT LOSS OF POWER



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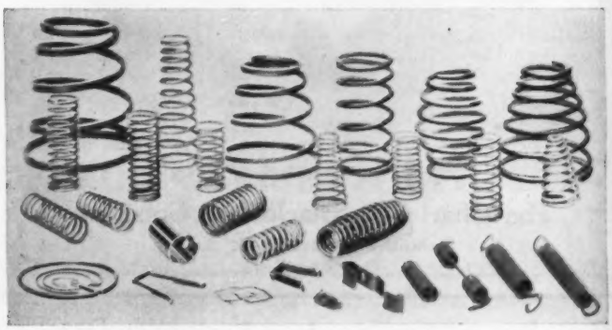

Few realize, even among engineers, how much of engineering design, proper calculation of stresses, metallographic selection of materials, and scientific heat treatment, is involved in the production of a high grade spring—

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Three properly "engineered" systems are described in our Booklet on Automobile Painting. It is yours for the asking.

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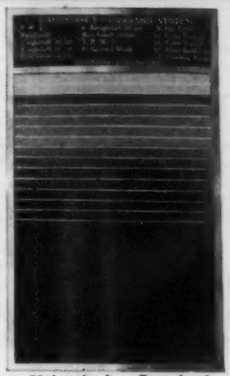
New York Chicago Boston



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Are comparatively rapid and inexpensive.
Do not mar finished surfaces.
Do not strain and start fractures in metal.
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The only instrument that measures material from extreme thinness to unlimited size.
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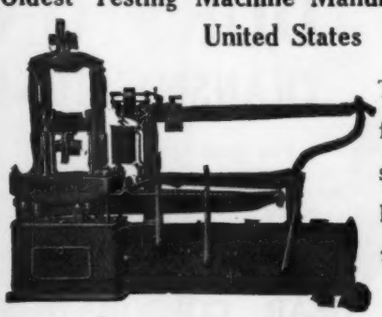
Oldest Testing Machine Manufacturers in the United States



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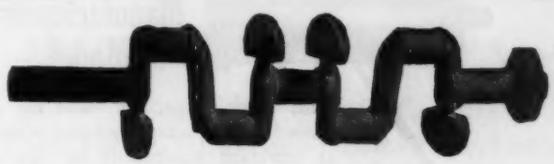

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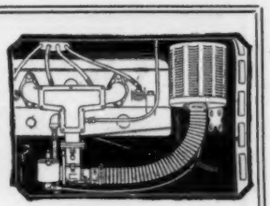
Perfect Positive Protection



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RUSCO Brake Lining has outtested all the road stopping-standards set by engineers and police. Try it out on your own car!

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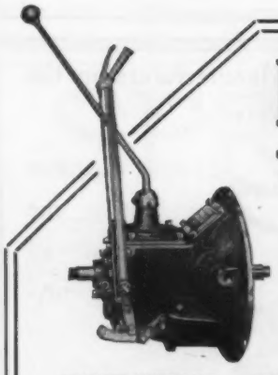

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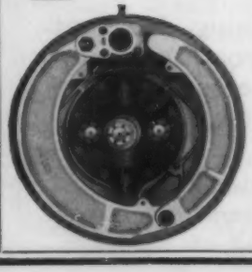

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4 Wheel Braking System

Complete Data on Request

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Let us Produce it for You!

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Give full facts as to patents, state of development, etc., in first letter.

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Incorporated
Differential Gear Mfrs.
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We are building axle housings, brake drums, and other parts for the heaviest motor trucks ever built, and have ample capacity for still heavier.
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We solicit your inquiries.
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Capacity 2000 Tons Per Month
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the King of
Tappet Wrenches
The Automotive Mechanics favorite set put up in a handy Kit. These Wrenches are drop forged from Chrome Vanadium steel. Long, light, sure-gripping, extra strong, ideal for the whole range of Tappet work.
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THE HERBRAND COMPANY
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Manufacturers of
Cold Drawn, Milled and Ground Specialties
Shafting and Screw Steel
Rounds, Hexagons, Flats, Squares and Special Shapes
Machine Keys, Machine Racks
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Radiators
THE G & O MANUFACTURING CO.
Tubular and Honeycomb Radiators
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Laminated Shims are made of thin layers of brass, which are peeled off to secure the thickness required for accurate bearing adjustments. Furnished babbitt-faced or plain. In standard patterns or to order.
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Alloys, Alumino-Vanadium
Vanadium Corporation of America
Alloys, Cupro-Vanadium
Vanadium Corporation of America
Alloys, Ferro-Molybdenum
Vanadium Corporation of America
Alloys, Ferro-Tungsten
Vanadium Corporation of America
Alloys, Ferro-Vanadium
Vanadium Corporation of America
Alloys, Steel (See Steels)
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*Sterling Mfg. Co.
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Apparatus, Charging, Electric Vehicle
Westinghouse Electric & Mfg. Co.
Apparatus, Ignition**
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*North East Electric Co.
Westinghouse Electric & Mfg. Co.
Apparatus, Laboratory
Olsen Testing Machine Co., Tinius
Appliances, Gas
Prest-O-Lite Co.
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Axles, Trailer
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Timken-Detroit Axle Co.
Babbitt, D103
*Federal-Mogul Corporation
*Light Mfg. & Foundry Co.
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Hoover Steel Ball Co.
Balls, Hollow Bronze and Brass
Hoover Steel Ball Co.
Balls, Steel
Hoover Steel Ball Co.
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Bars, Bronze
Mueller
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Batteries, Farm Lighting
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*Electric Storage Battery Co.
*Prest-O-Lite Co.
*Westinghouse Union Battery Co.
*Willard Storage Battery Co.
Batteries, Storage, Starting and Lighting, B23
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*Prest-O-Lite Co.
*Westinghouse Union Battery Co.
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Bunting Brass & Bronze Co.
Doehler Die-Casting Co.
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Bunting Brass & Bronze Co.
Doehler Die-Casting Co.
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Mueller
Stewart Mfg. Corporation
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*Fafnir Bearing Co.
*Marlin-Rockwell Corporation
*New Departure Mfg. Co.
*S K F Industries, Inc.
*Strom Ball Bearing Mfg. Co.
Bearings, Ball, Annular, Extra Large, Light and Medium Series, C27 and C29
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*Marlin-Rockwell Corporation
*S K F Industries, Inc.
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*New Departure Mfg. Co.
*Norma Co. of America
*S K F Industries, Inc.
*Strom Ball Bearing Mfg. Co.
Bearings, Ball, Annular, Light, Medium and Heavy Series, C26, C28 and C30
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*Federal Bearings Co., Inc.
*Marlin-Rockwell Corporation
*New Departure Mfg. Co.
*Norma Co. of America
*S K F Industries, Inc.
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*New Departure Mfg. Co.
*S K F Industries, Inc.
*Strom Ball Bearing Mfg. Co.
Bearings, Ball, Thrust, Single-Direction, Flat-Face Type, C35 and C36
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*Bearings Co. of America
*Fafnir Bearing Co.
*Norma Co. of America
*Strom Ball Bearing Mfg. Co.
Bearings, Ball, Thrust, Single-Direction, Self-Aligning Type, C37 and C38
*Bantam Ball Bearing Co.
*Bearings Co. of America
*Fafnir Bearing Co.
*Norma Co. of America
*S K F Industries, Inc.
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Mueller
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Bower Roller Bearing Co.
Gilliam Mfg. Co.
*Hyatt Roller Bearing Co.
*Norma Co. of America
*S K F Industries, Inc.
*Shafer Bearing Corporation
Bearings, Roller, Straight, Inch-Type
Hyatt Roller Bearing Co.
Norma Co. of America
Bearings, Roller, Tapered, Inch-Type
Timken Roller Bearing Co.
Bearings, Thrust, Ball, Clutch Release Type, C39
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*Bearings Co. of America
*Fafnir Bearing Co.
*Norma Co. of America
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Timken Roller Bearing Co.
Belting, Tractor, E51
*Russell Mfg. Co.
Belts, 'V' Fan, A14a
*Gilmer Co., L. H.
Belts, Flat Fan, A14a
*Gilmer Co., L. H.
*Russell Mfg. Co.
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Carter Co., George R.
Blanks, Gear
Canton Drop Forging & Mfg. Co.
Central Steel Co.
Link-Belt Co.
Park Drop Forge Co.
Union Switch & Signal Co.
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Parish Mfg. Corporation
Bodies, Passenger Car
Baker R & L Co.
Bolts, Carriage
Columbus Bolt Works Co.
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*National Acme Co.
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Williams & Co., J. H.
Bolts, Fender
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Bolts, King
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Steel Products Co.
Bolts, Spring-Center, H4
*National Acme Co.
Bolts, Spring Shackle
Bowen Products Corporation
Ferry Cap & Set Screw Co.
Steel Products Co.
Bolts, Step
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Bolts, Tie-Rod
Ferry Cap & Set Screw Co.
Steel Products Co.
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Hydraulic Brake Co.
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Laminated Shim Co., Inc.
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Carter Co., George R.
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*Brown Mfg. Co., Jno. W.
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*Byrne, Kingston & Co.
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*Light Mfg. & Foundry Co.
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Mueller
Scovill Mfg. Co.
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*Light Mfg. & Foundry Co.
Milwaukee Die Casting Co.
Mueller
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*American Malleable Castings Association
*Eberhard Mfg. Co.
*Link-Belt Co.
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*Link-Belt Co.
Chains, Block
Link-Belt Co.
Morse Chain Co.
Whitney Mfg. Co.
Chains, Roller, E3
*Link-Belt Co.
*Whitney Mfg. Co.
Chains, Silent, E2
*Link-Belt Co.
*Morse Chain Co.
Whitney Mfg. Co.
Channels, Window Glass
Dahlstrom Metallic Door Co.
Checks, Door
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Schrader's Son, Inc., A.
Clamps, Machinists'
Eberhard Mfg. Co.
Williams, J. H., & Co.
Cleaners, Windshield
Folberth Auto Specialty Co.
Clips, Spring, H3
Columbus Bolt Works Co.
Clutches, Engine**
*Brown-Lipe Gear Co.
Spicer Mfg. Corporation
Clutches, Power Transmission
Link-Belt Co.
Coils, Electrical Equipment
Acme Wire Co.
Dayton Engineering Laboratories Co.
Condensation Products
Bakelite Corporation
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Schrader's Son, Inc., A.
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Perrot Brake Corporation
Controls, Transmission
Brown-Lipe Gear Co.
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Dogs, Lathe
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EXPLANATION OF SYMBOLS

Parts and materials followed by key numbers have been standardized by the S. A. E. The numbers refer to S. A. E. HANDBOOK data sheets on which each standard is published.

*Companies whose names are preceded by an asterisk supply the parts or materials under which the company is listed as conforming with the S. A. E. Standard referred to.

**Parts and materials followed by two asterisks indicate that two or more S. A. E. Standards are applicable. Information as to standards incorporated should be obtained from the manufacturer.

The addresses of companies listed in this index can be obtained from their current advertisements indexed on page 112.

Certificate Holders for the Quarter Ending March 31st, 1924

Albany Malleable Iron Co.	Voorheesville, N. Y.
Albion Malleable Iron Co.	Albion, Mich.
American Chain Co.	Bridgeport, Conn.
American Malleable Castings Co.	Marion, O.
American Malleables Co.	Lancaster, N. Y., and Owosso, Mich.
Badger Malleable & Mfg. Co.	South Milwaukee, Wis.
Baltimore Malleable Iron & Steel Casting Co.	Baltimore, Md.
Belle City Malleable Iron Co.	Racine, Wis.
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Chicago Malleable Castings Co.	West Pullman, Chicago, Ill.
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Danville Malleable Iron Co.	Danville, Ill.
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York Mfg. Co.	York, Pa.
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High Yield Point is what the Engineer Wants

Engineers responsible for the design of machines in which vital parts must withstand shock and abuse freely use Certified Malleables because of their high elastic limit (yield point) compared to other ferrous castings.

Yield point of Certified Malleables is 65% of ultimate strength
Yield point of Steel Castings is 45% of ultimate strength

Certified Malleables all average higher than 50,000 pounds tensile strength with yield point of 33,000 pounds or higher. This is about 6000 pounds or 22% higher than Class A Steel Castings and exceeds by a considerable margin the yield point of medium and soft Class B Steel Castings, having tensile strengths of 70,000 and 60,000 pounds respectively.

Along with their high elastic limit, Certified Malleables machine more easily and economically than other ferrous castings. After annealing, all Certified Malleables contain minute particles of free temper carbon or graphite which serves as a natural lubricant for the cutting tool, while freedom from blow holes and hidden defects prevents "rejects" after expensive machining labor has been expended.

AMERICAN MALLEABLE CASTINGS ASSOCIATION
UNION TRUST BUILDING CLEVELAND, OHIO

POSITIVE PHYSICAL PROPERTIES
AcA CERTIFIED

CERTIFIED-MALLEABLE CASTINGS

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Charged Bone-Dry Ends Battery Waste

WILLARD CHARGED BONE-DRY BATTERIES save money for every one who makes, sells or drives an automobile.

The pictures show how this very different battery is made.

Charged Plates with Threaded Rubber Insulation. Plates and insulation assembled dry. Dry as a bone inside. Sealed to keep it dry. No acid in the battery when it is built. That is the difference, and here is the reason.

Storage Batteries start their lives the minute they are filled with acid solution.

But this battery is CHARGED BONE-DRY when it is made. It needs no further charging to be ready when wanted. It is not necessary to fill it before the owner is ready to use it.

Consequently not a particle of its life is wasted.

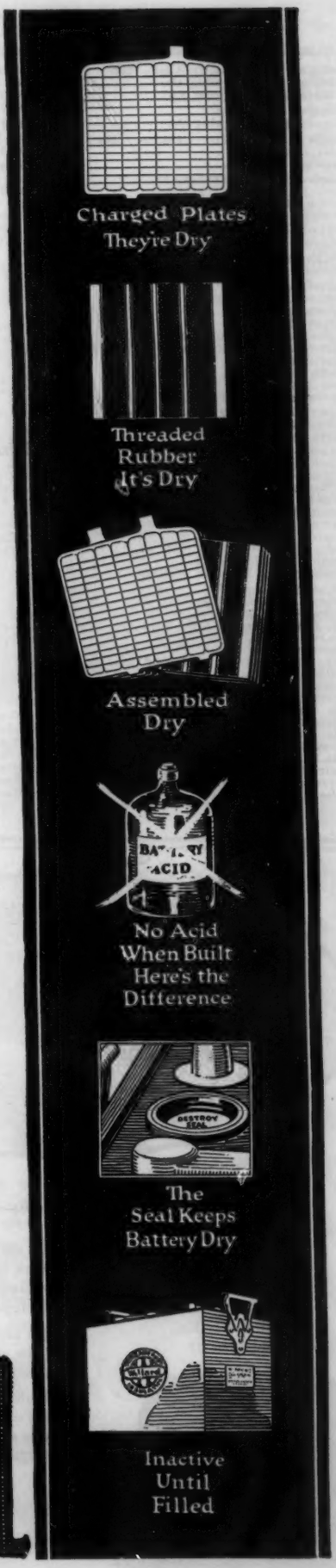
As equipment for new cars this means more battery life in the car. Greater good-will for car builder and car dealer.

For replacements of worn out batteries it means that the owner can *see the battery filled when he buys it.*

For Service Stations greater convenience in handling, and for Radio Dealers a *battery that can be carried in stock without acid.*

WILLARD STORAGE BATTERY COMPANY, CLEVELAND, OHIO
In Canada the Willard Storage Battery Co. of Canada, Limited, Toronto, Ont.

No acid in it until you fill it


Charged Plates They're Dry
Threaded Rubber It's Dry
Assembled Dry
No Acid When Built Here's the Difference
The Seal Keeps Battery Dry
Inactive Until Filled

Willard STORAGE BATTERIES

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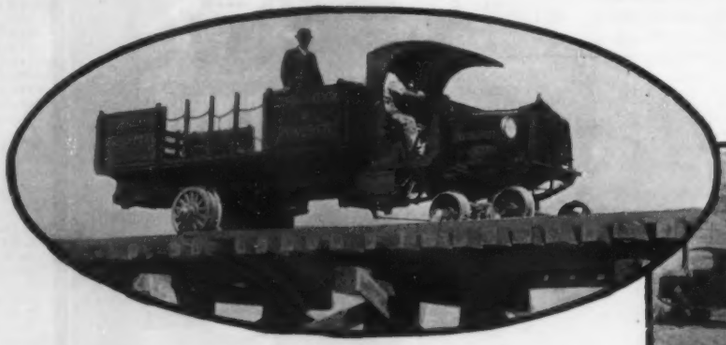

Selden Motor Trucks operating on the Tugalo River Development Project of the Georgia Railway & Power Co.

EXACTING SERVICE!

The above illustrations depict a Selden Motor Truck operating on the standard gauge tracks of the Georgia Railway and Power Company at their development on the Tugalo River, Georgia.

This represents another important step forward in the use of automotive equipment in railway haulage.

The location of this development is in a wilderness of the Georgian hills where the necessity for using component parts, tested by time, was fully recognized by the Selden Motor Truck Engineers.

They knew that ignition was of paramount importance and that the Eisemann Magneto could be relied upon as an unfailing source of positive ignition.

Eisemann is standard equipment on Selden Motor Trucks as well as on the products manufactured by the vast majority of leading truck and bus builders.

If proven worth is a factor to be considered, the Eisemann Magneto demands first thought in ignition specifications.

Type G4 II Ed.
MAGNETO

CORRESPONDENCE INVITED

EISEMANN MAGNETO CORPORATION
165 Broadway, N. Y.
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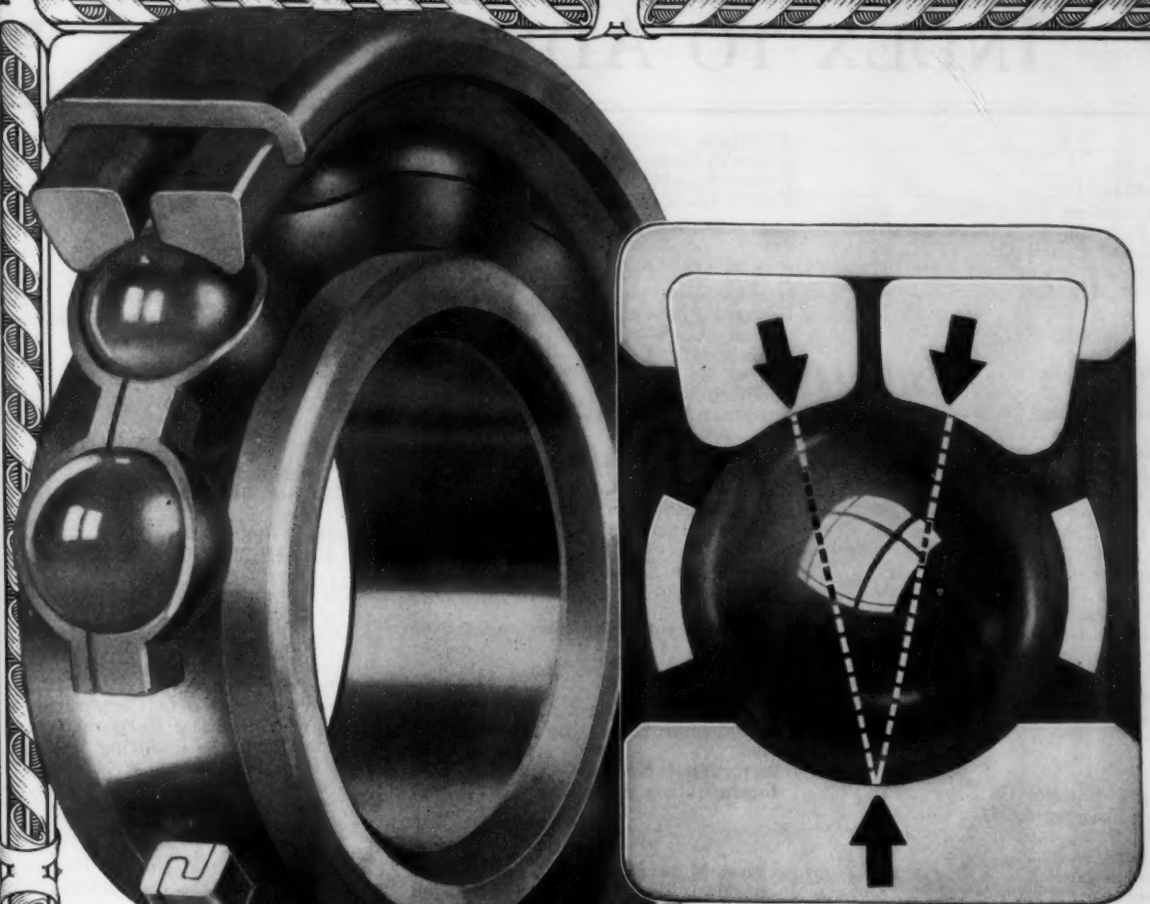

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They're going to materially reduce engine wear and make it unnecessary to change oil so frequently because of dirt and grit.

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When you turn your attention to oil tests with your new filter, be sure to test Sunoco. It will strikingly repay your trouble. A minimum of clogging; a maximum retention of lubricating value in long use.

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Diagram at right shows effect of crankcase distortion on gear drives. Slight changes in center distances mean noisy gears.

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FACTORIES which insist on quality do not send out engines with noisy "front-end" drives. With gear drive, and at times even with rigid types of chain drive, *crankcase distortion sets at naught the efforts of the manufacturer to secure quiet operation.*

The crankcase after it leaves the manufacturing line may be accurate. It may check up with all the inspection fixtures but after assembly it may be "off" to a considerable degree. Taking up the supporting studs and cap screws may have thrown it out of alignment.

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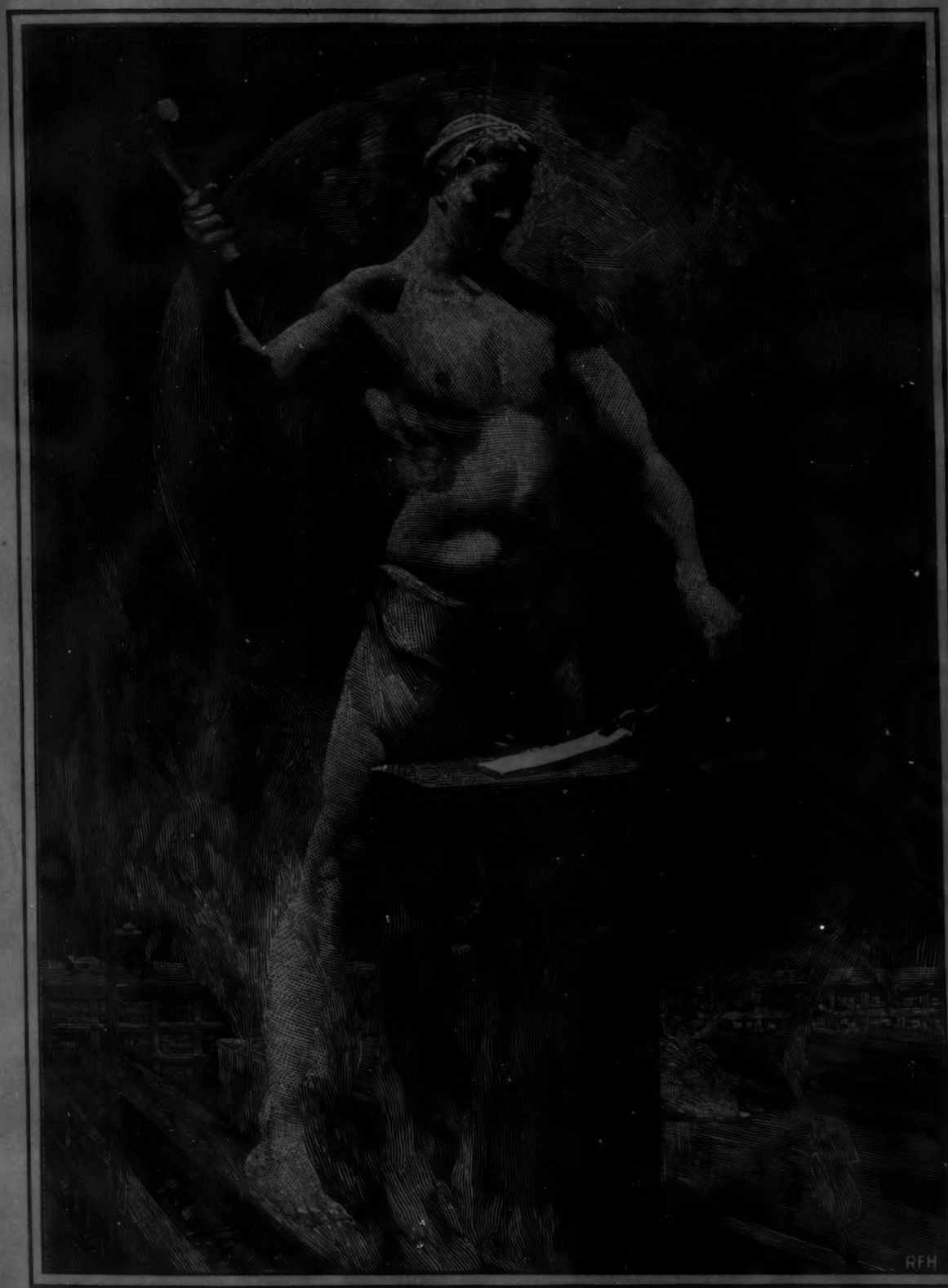

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JUNE, 1924